Dayton Metro Library – Segment III
Southeast Branch
Bid Release #1

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GENERAL INSTRUCTIONS TO BIDDERS
For
Dayton Metro Library – Southeast Branch
Bid Release #1

1. NOTICE
Shook Construction Company, Construction Manager Agency, acting as the owner’s agent, for the Dayton Metro Library – Southeast Branch project located at 21 Watervliet Avenue, Dayton, Ohio 45420, is requesting sealed proposals for the portion of the project on the dates and at the times to be stated below:

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The Owner or Construction Manager reserves the right to reject any and all bids, accept bids in any order or combination, accept or reject portions of bids, make modifications to the work after bidding and waive any informality in bids if they deem it in their best interest to do so.

The advertised estimate for the Southeast Branch is $6,893,978.

2. PROPOSAL
Bids shall be prepared and submitted on the “Form of Proposal” supplied by Shook Construction Company and attached to the Bid Package Documents. Fully executed proposal forms, subject to all requirements of the Contract Documents shall be submitted to the construction manager:

Shook Construction
4977 Northcutt Place
Dayton, Ohio 45414

No interlineations, exclusions, or special conditions shall be made or included in the proposal form by the Bidder. Conditional bids will not be accepted, nor will oral or telephone. **Hard copy bids will be received at the above address.** Erasures or other changes in the bids must be explained or noted over the signature of the Bidder.

Each Bidder, by making his bid, represents that:

(a) He has read and understands the Bidding Documents and his bid is made in accordance therewith.
(b) He has familiarized himself with the site and local conditions under which the work is to be performed.
(c) His bid is based upon the materials, system and equipment described or named in the bidding documents without exceptions.

Proposal shall be enclosed in a sealed opaque envelope on which shall appear the project name, bid package number, name and address of bidder, and date and time for receipt of bid. If the bid is sent
by mail, the sealed envelope shall be enclosed in a separate mailing envelope with the notation “BID ENCLOSED” on the face thereof, addressed to the owner’s office at the address given above.

For the information of those delivering bids by hand, they should be brought to the above address and given to the secretary for time and date stamping.

The bid shall include the legal name of bidder and a statement whether bidder is a sole proprietor, a partnership, a corporation, or any other legal entity and each copy shall be signed by the person or persons legally authorized to bind the bidder to a contract. A bid by a corporation shall further give the state of incorporation and affix seal. **A bid bond, bid affidavit, inclusion participation form(last page of the bid form), and power of attorney shall accompany the bid.**

3. **Pre-Bid**

Each trade contractor should fully inform himself as to the facilities involved, the difficulties, restrictions, and logical extension of scope attending the performance of the trade contract. **Site visits are recommended and can be performed anytime.** A pre-bid meeting is scheduled for September 13th, 2017 @ 2pm held at Dayton Metro Library – Main Branch (Bassani Theater on Third Floor) located at 215 East Third Street, Dayton, Ohio 45402.

4. **BID BOND, POWER OF ATTORNEY, & BID AFFIDAVIT** – Required.

5. **PERFORMANCE & PAYMENT BOND** – Required.

6. **TIME FOR RECEIVING BIDS AND OPENING OF BIDS**

   Bids will be received until the specified time for the receipt of bids and the CM and Owner will decide when and where to publically open the bids. No bid received after the specified time for receipt of bids will be considered. No responsibility will be assumed for the premature opening of a bid not properly addressed and identified.

7. **MODIFICATION OR WITHDRAWAL OF BIDS**

   Bids may be withdrawn or modified on written or telegraphic request dispatched by the bidder and received by the construction manager prior to the time for receipt of bids, provided that written confirmation of any telegraphic withdrawal over the signature of the bidder shall be placed in the mail with postmark prior to the time set for receipt of bids. It shall be so worded as not to reveal the amount of the original bid.

   A bid may not be modified, withdrawn or cancelled by the bidder during the time period stated in the proposal following the time and date designated for the receipt of bids, and bidder so agrees in submitting his bid.

   Negligence on the part of the bidder in preparing his bid confers no right for the withdrawal of the bid after it has been opened.

8. **BIDDING DOCUMENTS**

   The Construction Manager’s Project Manual, including but not limited to, the Instruction to Bidders, Form of Proposal, Substitution Sheet, Contract, Bid package scope of work, Specifications and drawings will be provided electronically to all bidders. Documents can then be printed by each bidder as they see fit at the bidder cost.
Bidding documents include the following:

(a) Shook Construction Bid Manual documents prepared by Shook Construction.

(b) Technical Specifications and Drawings as prepared by Levin Porter Architects.

9. TAXES

Project is tax exempt.

10. INSPECTION OF SITE

Each bidder should visit the site of the proposed work and fully acquaint himself with the existing conditions there relating to construction and labor. He should fully inform himself as to the facilities involved, the difficulties, restrictions and logical extension of scope attending the performance of the contract. The bidder should thoroughly examine and familiarize himself with the drawings, technical specifications and all other contract documents. The trade contractor, by the execution of the contract, shall in no way be relieved of any obligation under it due to his failure to receive or examine any form or legal instrument or to visit the site and acquaint himself with the conditions there existing. The Construction Manager will reject any claim based on facts regarding which the trade contractor should have been knowledgeable.

11. ADDENDA AND INTERPRETATION

Bidders shall promptly notify the Construction Manager of any ambiguity, inconsistency or error which they may discover upon examination of the bidding documents or the site and local conditions. No oral explanation in regards to the meaning of the contract documents will be made and no oral instructions will be given before the award of a contract. Discrepancies, omissions, questions, needs for clarification, or interpretation or doubts as to the true meaning of the contract documents, should be communicated at once to the CM who shall thereafter notify the A/E. The A/E with time permitting, will issue a written instruction in the form of an addendum to all bidders of record and its receipt by the bidder must be listed on the Form of Proposal. Every question or request for clarification or interpretation should be addressed to the Construction Manager.

12. BASE BID

Attention is called to the General Conditions. Base bid to include all costs for properly manning the job to meet the schedule agreed upon between contractor and Construction Manager.

13. ALTERNATE PRICES

Alternate prices may be considered. The Construction Manager, subject to architect’s review, shall have the right to accept alternates in any order or combination and to have the right to accept and to determine the lowest responsible bidder on the basis of the sum of the base bid and the alternates accepted.

VOLUNTARY ALTERNATES MAY BE CONSIDERED. VOLUNTARY ALTERNATES WITH DOLLAR VALUES, IF PROPOSED, ARE TO BE IDENTIFIED ON THE BID FORM IN THE SPACE PROVIDED.
14. **PRE-AWARD INFORMATION**

The bidder will be required to establish to the satisfaction of the Construction Manager and the Owner, the reliability and responsibility of the bidder, his proposed subcontractors and material suppliers to furnish and perform the work bid.

Upon request, the bidder shall submit proposed field organization, plan for execution of the work, or any other additional information required by the Construction Manager.

Prior to the award of the contract, the Construction Manager will notify the bidder if he, the Owner or the Architect, after due investigation, has reasonable and substantial objection to any person or organization submitted. If such an objection is expressed, and if the Construction Manager, the Owner, or the Architect refuses in writing to accept such person or organization, the bidder may submit an acceptable substitute with an increase or a decrease in his bid price to cover the difference in cost occasioned by such substitution. The Construction Manager may, at his discretion, accept the revised bid price or he may disqualify the bidder.

Subcontractors and other persons and organizations proposed by the bidder and accepted by the Construction Manager, the Owner and the Architect, must be used on the work for which they were proposed and accepted, and shall not be changed except with the written approval of the Construction Manager, the Owner and the Architect.

Notwithstanding anything to the contrary contained herein, the Construction Manager reserves the right to remove, or cause to be removed from the project, any employee of the Trade Contractor or his subcontractors, whenever he deems, in his sole discretion, such action to be in the best interest of the project.

Bidder or Bidders considered for contract award shall, upon request of the Construction Manager, submit any or all of the following information:

a. List of Contractor’s current work under contract and pending.

b. List of subcontractors, if applicable, that the bidder intends to use to perform part of the work under this bid package.

15. **FORM OF CONTRACT**

Each bidder, by submitting a proposal, agrees to execute the respective standard owner contract, which is one of the contract documents, the term trade contractor, contractor and subcontractor are interchangeable.

16. **AWARD OF CONTRACTS**

It is intended to make each award promptly and for the Work to start as soon thereafter as possible, but bids may be held for a period not to exceed the days stated in the proposal, and no bidder may withdraw his bid during these periods.

Award of contracts for each bid package will be made to the lowest responsible bidder.

Shook Construction and the Owner reserve the right to reject any and all bids and to waive any informalities in bidding, if it is in the Owner’s interest to do so and at their sole discretion. The Owner will not award the contract to any trade contractor who is, at the time of award ineligible for
such contract under the provision of any applicable regulations issued by the Secretary of Labor, United States Department of Labor, or is not qualified under applicable Federal, State, or Local laws or regulations.

**SUBSTITUTIONS**

No substitutions will be considered unless written request for approval has been submitted by the Bidder to the Construction Manager at least five days prior to the date for receipt of bids. Written requests for substitutions shall be addressed to Shook Construction. The materials, products and equipment described or named in the bidding documents establish a standard or required function, dimension, appearance and quality to be met by any proposed substitution. Each bid shall be based upon the materials and equipment described or named in the bidding documents. Where systems or products are designated in the specifications or on the drawings by reference to trade names, manufacturer’s names, model numbers, catalog numbers, etc., the bids shall be based on the specific system or products so designated and the contract will be awarded on that basis.

Requests for substitutions are encouraged where the bidder considers that the proposed substitute will offer better service facilities or more advantageous delivery date or lesser price, with credit to the Owner, without sacrificing quality, appearance or function. It shall be understood that approval or rejection is in no way an endorsement or derogation of the product.

Each substitution request shall include the name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including drawing, cuts, performance and test data and any other information necessary for an evaluation. A statement setting forth any changes in other materials, equipment or work that incorporation of the substitute would require shall be included. The burden of proof of the merit of the proposed substitute is upon the proposer. The Construction Manager’s decision, subject to Architect’s review, of approval or disapproval of a proposed substitution shall be final.

18. **SCHEDULES**

Work to commence immediately upon award. See Milestone Schedule within bid documents.

19. **COMPLETION OF THE WORK**

Time is of the essence of the Contract, and time or date of completion is specified above. It shall be mutually understood and agreed by and between parties to the Construction Agreement that damage will be sustained by Owner should Contractor not complete his contract work by specified completion date.

Liquidated Damages - If work is not completed in the agreed upon project durations, including milestone dates being met (that are included in the trade contract agreement), $500 a calendar day will be assessed.

Each Trade Contractor is to coordinate the sequencing and staffing of his work with the project schedule. Any **overtime / double shift work** required to complete the work in the time allowed shall be included in the base bid. In the event that the contractor is behind schedule or has incurred lost work time during the normal week due to weather and/or acts of God, Saturday shall be used as a make-up day with no change in contract amount.
20. PERMITS

Each bidder shall include in his proposal for a complete job, all permits as may be required for his portion of the work. The General Building Permit will be obtained and paid for by the Owner. Trade Contractors are responsible for coordinating their respective inspections.

21. COMPLIANCE WITH CODES, ETC.

All Trade Contractors will be required to adhere to Federal, State and Local codes, rules regulations, procedures, advisories, etc., as well as all codes, rules, regulations, etc., of any group governing body or authority having jurisdiction over the project.

22. SAFETY REQUIREMENTS

All Trade Contractors will be required to comply with the provisions of the “Construction Safety Act” and the Occupational Safety and Health Act of 1970” and all additions and revisions thereto, to the extent that the provisions and standards thereof affect the work of this project, as well as all other applicable Federal, State and Local requirements. Please be advised that Shook Construction’s safety program goes above and beyond many OSHA regulations and will be required on this project. Please see the attached safety specification that outlines Shook Construction’s safety policy.

23. TEMPORARY ON-SITE FACILITIES

Each bidder must include in their proposal all costs for installation, maintenance and removal of temporary sheds, field offices, telephone service, and temporary electric. Actual use and location of office trailers and tool sheds must be coordinated with Construction Manager. Temporary toilet facilities and dumpsters are by this bidder for your duration of the work. A construction trailer must be provided by this contractor for daily/weekly meetings with the project team, including but not limited to, CM, Owner, testing agents, local authority, architects, engineers, CxA, etc. This trailer must be sized to handle a meeting with up to 30 people sitting around tables. Trailer to be in presentable condition, AC/Heat, electric, wireless internet, color copy machine with color scanning capabilities. Trailer must be equipped with tables, chairs, trash cans, coffee pot with coffee, drinking water, marker boards, etc. This trailer can be utilized as the prime contractor office trailer but must be available for the above mentioned personnel when needed.

24. ENGINEERING

Each bidder must include in his proposal, all costs for verifying the suitability of the work by others which affects the Trade Contractor’s work; perform all engineering and surveying and field measurements which may be required to complete his work.

25. INSURANCE

Each bidder must include in his proposal, all costs for the insurance requirements identified in these bid documents.

Before commencing the work, the contractor shall furnish full and complete certificates showing that Workers’ (Workmens’) Compensation coverage and such insurance is in force and further providing that such insurance shall not be cancelled, modified or not renewed without at least sixty (60) days prior written notice to CM. The Contractor agrees to maintain the products and
completed operations liability insurance, herein above described, in effect for duration of Guarantee/Warranty period.

Shook Construction, the owner, & the architect/engineer shall be listed as additional insured for the policies listed above.

26. LABOR STANDARDS – EEO & BWC Drug Workplace

All suppliers and trade contractors employed on this project are required to implement an Equal Employment Opportunity Program within their organization. Proper steps should be taken to establish non-discrimination because of race, color, age, creed, sex or national origin. The President’s Executive Order #11246 and modifications thereto, as well as other existing Federal and State legislation on Equal Employment Opportunities will be adhered to in the carrying out of the contract. Bidders for public contracts must submit an EEO certificate and proof of enrollment in the BWC Drug Free Workplace Program. These items will be asked for during the post bid interview process.

27. QUALIFICATION OF BIDDERS

The CM reserves the right to request a financial statement together with a statement of past experience, personnel, machinery, and equipment available to perform the proposed work from any bidder considered for award of a contract. Failure or refusal to furnish such a statement or statements, to provide such information or to provide a satisfactory statement of financial responsibility, may constitute a basis for disqualifying the bidder.

28. INCLUSION

The Owner and Construction Manager expect that all General Contractor and sub-tier contractors working on this project shall act in good faith and make reasonable awards of portions of their work to qualified sub-tier contractors as identified in the owner’s inclusion program detailed in TAB 7 of the bid documents.

29. PREVAILING WAGE

This project is a prevailing age project with certified payroll required. These payroll reports are to be submitted electronically with each monthly pay application.
NOTICE TO BIDDERS

Bids will be received by the Dayton Metro Library, at Shook Construction Company’s office located at 4977 Northcutt Place, Dayton, Ohio 45414 for the following Project:

Southeast Branch – Bid Release #1
Single Prime/GC

in accordance with the Drawings and Specifications prepared by:

Levin Porter Architects

The Construction Manager for the Project is:

Shook Construction Company
4977 Northcutt Place
Dayton, OH 45414
Phone No. 937-276-6666
Contact: Jaron Develbiss, Project Manager
Email address: jdevelbiss@shookconstruction.com

Any Proposed Equal for a Standard shall be submitted to the Engineer no later than ten (10 days prior to bid opening). If no Addendum is issued accepting the Proposed Equal, the Proposed Equal shall be considered rejected.

Sealed bids will be received for:

BR #1 – Single Prime/GC

until September 28th, 2017, at 2pm, when they will be opened and read.

Contract documents may be from Shook Construction Company in electronic format only. Hard copies can be obtained by the bidding contractor at their expense.

A pre-bid will be held on September 13th, 2017 @ 2pm at the office of Shook Construction Company, 4977 Northcutt Place, Dayton, Ohio 45416

The contract documents may be reviewed for bidding purposes without charge during business hours at the following locations:

Dayton Builders Exchange
2077 Embury Park Road
Dayton, OH 45414

Dayton Area Chamber of Commerce
Minority Business Partnership
22 E. Fifth Street, Chamber Plaza
Dayton OH 45402

Minority Contractors Business Asst.
201 Riverside Drive
Dayton, OH 45405

Advertise dates: 9-1-17 & 9-8-17
Bid Package 1 – Single Prime/GC

The following information is provided to define and describe the scope of work required of the successful Bidder and is intended to be complementary with the requirements of all other Contract Documents.

The scope of the work shall include, but not necessarily be limited to, providing the following:
Furnish all labor, tools, materials, taxes, fees, equipment and services as required to complete the package described in the following documents:
General Requirements as Stated in this Document.
Drawings by Levin Porter Architects and their consultants
Project Manuals written by Shook Construction.

Single Prime/GC Scope of Work

1. Provide & install all items identified on the bid documents.
2. Maintaining clean roads in and around the project site.
3. Temporary seeding of the site.
4. All topsoil to be reused shall be stockpiled on site in an area designated by the CM. Import Topsoil as required to meet final design requirements.
5. Building pad sub-grade preparation including stone sub-base, compaction and proof rolling.
   a) A registered survey of the building pad is required within 1 week of the completion of the building pad. Assume a 5’ grid.
6. Maintenance of erosion control for duration of project. Includes necessary documentation required following rain.
7. Removal of unsuitable soils as required per the soil reports and per the direction of the onsite geotech engineer. Bidding contractor is responsible for removing all unsuitable soils, disposing offsite, and importing structural fill (soil or granular) material to meet design requirements. Assume 1000 CY of unsuitable materials. See unit price section for this item.
8. Rock excavation shall include removal and disposal of the following: (1) all boulders measuring 1/3 of a cubic yard or more in volume; (2) all rock material in ledges, bedding deposits, and un-stratified masses which cannot be removed without systematic ram hammering or drilling and blasting. It is expected that all excavation can be accomplished using conventional equipment.
   a) For general excavation, a D-9N Caterpillar tractor with a single shank ripper, or equivalent equipment, is considered conventional equipment, if it can rip at a production rate of at least 300 bank cubic yards per hour.
   b) For trench excavation, a 345 Caterpillar excavator with a medium stick and a rock ripping bucket, or equivalent equipment, is considered conventional equipment, if it can excavate at a production rate of at least 30 bank cubic yards per hour.
c) If material is encountered which the CONTRACTOR believes cannot be excavated by conventional equipment, the ENGINEER shall be immediately notified. The CONTRACTOR shall provide performance tests of the specified conventional or equivalent equipment. If the ENGINEER confirms in writing that the specified conventional equipment cannot perform at the production rates specified, the excavation shall be considered rock excavation.

9. A permanent benchmark must be established. This benchmark should be utilized by other trades. Include a four feet elevation benchmark on all columns. Completed by a surveyor. Layout and engineering as required for work. Provide two sets of reference coordinates and a datum bench of a permanent nature as directed by CM.

10. Excess Soils to be removed from the site and if soil is needed, imported soil is required. Reference item #7 above.

11. Rework, tie-ins, demolition and capping of existing utilities as required.


13. All utility terminations shall be marked by a 4” by 4” post extending a minimum of 3’ above finished grade.

14. Traffic control and barricades as needed.

15. Dewatering as required.

16. As-built topographical survey upon completion of the work performed and certified by a licensed surveyor. Include building location, hardscape, final elevations grading plan to be utilized in other bid package releases, and depth of utilities on survey. Assume a 15’ grid.

17. Provide As-Built drawings of all utilities.

18. Establish, protect and maintain all excavations and slopes to provide a safe work area and as otherwise required by State, Local and Federal regulations & Safety Plan.

19. All Right-of-Way Bonds, etc. as required by City, County and State or other agencies relative to the work.

20. Permits and compliance required by governing authorities. General Building Permit is by the owner.

21. All warranties as required. All warranties start at Substantial Completion (certificate of occupancy) for all warranted items as long as complete item/system is complete. Mechanical systems warranty should not begin until all Cx items are 100% addressed.

22. Review the Site Logistics Plan and incorporate all items identified.

23. Permanent stone placement in parking lots and drive is to occur directly after utilities are complete and base course of asphalt. Surface course to be completed at very end of project.

24. Tap Fees and Geotechnical Services are by the owner.

25. Provide and install all wood blocking and metal backing as required. This includes but not limited to: cabinetry, signage, technology equipment, brackets, owner furnished items, railings, display boards, toilet accessories, door stops, roofing, walls, roof drains, roof curbs, roof openings, etc.

26. Dumpsters, temporary toilets, and drinking water for the duration of the project.

27. Markups for work additional work are limited to 5% overhead and 5% profit. Same for deduct change orders. Supt. time and management time are to be considered within the 5% overhead amount. No additional dollars will be considered on changes related to general condition items.
28. 3 week look ahead are to be turned in via email to the CM by Monday mornings @ 9am.
29. Temporary weather protection of masonry operations. This is not a part of the temp heat/air allowance.
30. Be a part of the door keying schedule and plan with the owner and architect.
31. Provide temporary cores for use by all – Qty. 15.
32. Provide a lockable building through temporary means when it makes sense – temporary and permanently enclosed.
33. Coordinate with all owner provided equipment, including technology, security, loose furniture, shelving, etc.
34. Provide and install and additional 3 access doors in a location determined by the CM. 30” by 30”.
35. Final coat of paint to not be installed until right before the punchlist stage.
36. Temporary fire extinguishers to be provided during construction on stands with emergency evacuation plans.
37. **Temporary Signage Allowance of $2,500.00 All costs applied to this shall not include any markups.**
38. **Temporary Heat Air Allowance of $25,000.00 All costs applied to this shall not include any markups.**
39. Steel must be ready to receive paint in exposed areas. Exposed steel that receives paint must be primed, welds ground, markings/tags removed, and bondo as needed.
40. Mockups as Specifications dictate.
41. Owner Training must be videotaped by the contractor and turned over on a CD and USB.
42. Protection of Materials during the construction process.
43. Final Cleaning shall be completed in two rounds. One before punchlist and one after punchlist.
44. Daily Cleanup is a must and all materials must be on carts or skids easily movable. Materials onsite shall be limited to items installed within 10 working days only.
45. All wall & floor penetrations regardless of a fire wall or design intent are required to be sealed.
46. Temporary enclosures are to be installed to keep the schedule moving and must be 100% by the building dry in milestone date.
47. If additional supports/items are needed to complete your “system” that are not shown on the documents, it is the bidders responsibility to include these items to produce a complete and warranted system.
48. Provide a third party water test on all storefront and curtainwall systems. This test is paid for by the contractor. This to be complete within 30 days of completion of the storefront & curtainwall systems.
49. All items exposed are to be labeled in a format approved by the architect/owner/CM.
50. Provide flooring waxing whether or not specified for all resilient flooring. Assume 6 coats.
51. This contractor is responsible for all LEED documentation including coordination with the owner, completing templates, uploading credits to the website, and responding to questions from the LEED organization.
52. Housekeeping pads are required whether shown or not. This includes but not limited to, mechanical equipment, electrical equipment, any conduit floor penetrations, plumbing equipment, fire protection equipment, etc.
53. Contractor to assume roof walk pads from roof access ladder to each piece of roof top equipment.
54. Include premium cost upcharges for long lead items in order to meet the project schedule.
55. Include all temporary electric necessary to complete the project.
56. Coordinate with owners CxA and testing agent. Schedule all items through both entities as necessary to complete the scope. Building Envelope Cx will be completed on this project. Contractor shall respond and be prepared to address any items identified on the Building Envelope infrared report.
57. Coordinate with owners other contractors to ensure a completely coordinated building.
58. Provide final cleaning of pavement, sidewalks, stoops, roofs, canopies, etc. at the very end of the project.
59. Coordinate and schedule all local utilities, including but not limited to, gas, water, electric, sanitary, fiber, phone, storm, etc.
60. Cost for electronic files are the responsibility of this contractor. Consult with the designers during the bidding process to determine the process for this request.
61. Provide video and pictures of existing conditions prior to mobilizing onsite.
62. All cabling in exposed areas to be concealed in conduits whether or not identified in the bidding documents.
63. Indoor Air Quality Testing for LEED & Cx purposes is to be completed & paid for by this contractor.
64. Assume two mobilizations for a painting, landscaping, and electrical subcontractor to coordinate with owner provided exterior signage.
65. Softball Field Relocation identified on the documents are by others and will be relocated prior to this project’s mobilization. All items that are a part of this softball field will be demolished and removed from the site by a previous contractor.
Standard Form of Agreement Between Owner and Contractor, Construction Manager as Adviser Edition

AGREEMENT made as of the « » day of « » in the year «20 »
(In words, indicate day, month and year.)

BETWEEN the Owner:
(Name, legal status, address and other information)

«Dayton Metro Library»
«215 East Third Street»
«Dayton, OH 45402»

and the Contractor:
(Name, legal status, address and other information)

«Shook Construction Company»
«4977 Northcutt Place»
«Dayton, Ohio 45414»

for the following Project:
(Name, location and detailed description)

«Dayton Metro Library – Southeast Branch – Bid Release #1 »
«215 East Third Street.»
«Dayton, OH 45402»

The Construction Manager:
(Name, legal status, address and other information)

«Shook Construction Company»
«4977 Northcutt Place»
«Dayton, Ohio 45414»

The Architect:
(Name, legal status, address and other information)

«Dayton Design Collaborative»
« »
«Dayton, OH 45402»

The Owner and Contractor agree as follows.

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**ARTICLE 1  THE CONTRACT DOCUMENTS**

The Contract Documents consist of this Agreement, Conditions of the Contract (General, Supplementary and other Conditions), Drawings, Specifications, Addenda issued prior to execution of this Agreement, other documents listed in this Agreement and Modifications issued after execution of this Agreement, all of which form the Contract, and are as fully a part of the Contract as if attached to this Agreement or repeated herein. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior negotiations, representations or agreements, either written or oral. An enumeration of the Contract Documents, other than Modifications, appears in Article 9.

**ARTICLE 2  THE WORK OF THIS CONTRACT**

The Contractor shall fully execute the Work described in the Contract Documents, except as specifically indicated in the Contract Documents to be the responsibility of others.

**ARTICLE 3  DATE OF COMMENCEMENT AND SUBSTANTIAL COMPLETION**

§ 3.1 The date of commencement of the Work shall be the date of this Agreement unless a different date is stated below or provision is made for the date to be fixed in a notice to proceed issued by the Owner.

(Insert the date of commencement, if it differs from the date of this Agreement or, if applicable, state that the date will be fixed in a notice to proceed.)

§ 3.2 The Contract Time shall be measured from the date of commencement.

§ 3.3 The Contractor shall achieve Substantial Completion of the entire Work not later than «   /   » («   »)

(Insert number of calendar days. Alternatively, a calendar date may be used when coordinated with the date of commencement. If appropriate, insert requirements for earlier Substantial Completion of certain portions of the Work.)
«Contractor shall achieve Substantial Completion and Final Completion of the Work on the dates set forth in the Milestone Dates Schedule set forth on Exhibit A attached hereto and made a part hereof. The Work shall be performed in accordance with the Milestone Dates Schedule and Construction Schedule attached hereto as Exhibit B and by such attachment made a part hereof.»

<table>
<thead>
<tr>
<th>Portion of the Work</th>
<th>Substantial Completion Date</th>
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, subject to adjustments of this Contract Time as provided in the Contract Documents.

(Insert provisions, if any, for liquidated damages relating to failure to achieve Substantial Completion on time or for bonus payments for early completion of the Work.)

«»

ARTICLE 4 CONTRACT SUM

§ 4.1 The Owner shall pay the Contractor the Contract Sum in current funds for the Contractor’s performance of the Contract. The Contract Sum shall be one of the following:

(Check the appropriate box.)

[ «X» ] Stipulated Sum, in accordance with Section 4.2 below

[ « » ] Cost of the Work plus the Contractor’s Fee without a Guaranteed Maximum Price, in accordance with Section 4.3 below

[ « » ] Cost of the Work plus the Contractor’s Fee with a Guaranteed Maximum Price, in accordance with Section 4.4 below

(Based on the selection above, complete Section 4.2, 4.3 or 4.4 below. Based on the selection above, also complete either Section 5.1.4, 5.1.5 or 5.1.6 below.)

§ 4.2 Stipulated Sum

§ 4.2.1 The Stipulated Sum shall be « » ($ « 0.00 » ), subject to additions and deletions as provided in the Contract Documents. The Stipulated Sum is allocated and detailed on the Schedule of Values attached hereto as Exhibit C and by such attachment made a part hereof.

§ 4.2.2 The Stipulated Sum is based on the following alternates, if any, which are described in the Contract Documents and are hereby accepted by the Owner:

(Identify and state the unit price, and state the quantity limitations, if any, to which the unit price will be applicable.)

§ 4.2.3 Unit prices, if any:

(Identify allowance and state exclusions, if any, from the allowance price.)

§ 4.2.4 Allowances included in the Stipulated Sum, if any:
ARTICLE 5 PAYMENTS
§ 5.1 Progress Payments
§ 5.1.1 Based upon Applications for Payment submitted to the Construction Manager by the Contractor, and upon certification of the Project Application and Project Certificate for Payment or Application for Payment and Certificate for Payment by the Construction Manager and Architect and issuance by the Architect, the Owner shall make progress payments on account of the Contract Sum to the Contractor as provided below and elsewhere in the Contract Documents.

§ 5.1.2 The period covered by each Application for Payment shall be one calendar month ending on the last day of the month, or as follows:

« »

§ 5.1.3 Provided that an Application for Payment is received by the Construction Manager not later than the twentieth «20th» day of a month, the Owner shall make payment of the certified amount in the Application for Payment to the Contractor not later than the «last» day of the «following» month.

(Federal, state or local laws may require payment within a certain period of time.)

§ 5.1.4 Progress Payments Where the Contract Sum is Based on a Stipulated Sum
§ 5.1.4.1 Each Application for Payment shall be based on the most recent schedule of values submitted by the Contractor in accordance with the Contract Documents. The schedule of values shall allocate the entire Contract Sum among the various portions of the Work and be prepared in such form and supported by such data to substantiate its accuracy as the Construction Manager and Architect may require. This schedule, unless objected to by the Construction Manager or Architect, shall be used as a basis for reviewing the Contractor’s Applications for Payment.

§ 5.1.4.2 Applications for Payment shall show the percentage of completion of each portion of the Work as of the end of the period covered by the Application for Payment.

§ 5.1.4.3 Subject to the provisions of the Contract Documents, the amount of each progress payment shall be computed as follows:

.1 Take that portion of the Contract Sum properly allocable to completed Work as determined by multiplying the percentage completion of each portion of the Work by the share of the total Contract Sum allocated to that portion of the Work in the schedule of values, less retainage of «eight» percent («8»%). Pending final determination of cost to the Owner of changes in the Work, amounts not in dispute may be included as provided in Section 7.3.9 of the General Conditions;

.2 Add that portion of the Contract Sum properly allocable to materials and equipment delivered and suitably stored at the site for subsequent incorporation in the completed construction (or, if approved in advance by the Owner, suitably stored off the site at a location agreed upon in writing), less retainage of «eight» percent («8»%);

.3 Subtract the aggregate of previous payments made by the Owner; and

.4 Subtract amounts, if any, for which the Construction Manager or Architect has withheld or nullified a Certificate for Payment as provided in Section 9.5 of the General Conditions.

§ 5.1.4.4 The progress payment amount determined in accordance with Section 5.1.4.3 shall be further modified under the following circumstances:

.1 Add, upon Substantial Completion of the Work, a sum sufficient to increase the total payments to «ninety-five» percent («95»%) of the Contract Sum, less such amounts as the Construction Manager recommends and the Architect determines for incomplete Work and unsettled claims; and

.2 Add, if final completion of the Work is thereafter materially delayed through no fault of the Contractor, any additional amounts payable in accordance with Section 9.10.3 of the General Conditions.

§ 5.1.4.5 Reduction or limitation of retainage, if any, shall be as follows:

(If it is intended, prior to Substantial Completion of the entire Work, to reduce or limit the retainage resulting from the percentages inserted in Sections 5.1.4.3.1 and 5.1.4.3.2 above, and this is not explained elsewhere in the Contract Documents, insert here provisions for such reduction or limitation.)
§ 5.1.6.5 The Owner and the Contractor shall agree upon a (1) mutually acceptable procedure for review and approval of payments to Subcontractors and (2) the percentage of retainage held on Subcontracts, and the Contractor shall execute subcontracts in accordance with those agreements.

§ 5.1.6.6 In taking action on the Contractor’s Applications for Payment, the Construction Manager and Architect shall be entitled to rely on the accuracy and completeness of the information furnished by the Contractor and shall not be deemed to represent that the Construction Manager or Architect have made a detailed examination, audit or arithmetic verification of the documentation submitted in accordance with Section 5.1.6.1 or other supporting data; that the Construction Manager or Architect have made exhaustive or continuous on-site inspections; or that the Construction Manager or Architect have made examinations to ascertain how or for what purposes the Contractor has used amounts previously paid on account of the Contract. Such examinations, audits and verifications, if required by the Owner, will be performed by the Owner’s auditors acting in the sole interest of the Owner.

§ 5.1.6.7 Except with the Owner’s prior approval, the Contractor shall not make advance payments to suppliers for materials or equipment which have not been delivered and stored at the site.

§ 5.2 Final Payment

§ 5.2.1 Final payment, constituting the entire unpaid balance of the Contract Sum, shall be made by the Owner to the Contractor when

.1 the Contractor has fully performed the Contract except for the Contractor’s responsibility to correct Work as provided in Section 12.2 of AIA Document A232–2009, and to satisfy other requirements, if any, which extend beyond final payment;

.2 the Contractor has submitted a final accounting for the Cost of the Work, pursuant to Exhibit A, Determination of the Cost of the Work when payment is on the basis of the Cost of the Work, with or without a Guaranteed Maximum payment; and

.3 a final Certificate for Payment or Project Certificate for Payment has been issued by the Architect; such final payment shall be made by the Owner not more than 30 days after the issuance of the final Certificate for Payment or Project Certificate for Payment, or as follows:

ARTICLE 6 DISPUTE RESOLUTION

§ 6.1 Initial Decision Maker

The Architect will serve as Initial Decision Maker pursuant to Section 15.2 of AIA Document A232–2009, unless the parties appoint below another individual, not a party to this Agreement, to serve as Initial Decision Maker.

(If the parties mutually agree, insert the name, address and other contact information of the Initial Decision Maker, if other than the Architect.)

§ 6.2 Binding Dispute Resolution

For any Claim subject to, but not resolved by, mediation pursuant to Section 15.3 of AIA Document A232–2009, the method of binding dispute resolution shall be as follows:

(If the Owner and Contractor do not select a method of binding dispute resolution below, or do not subsequently agree in writing to a binding dispute resolution method other than litigation, Claims will be resolved by litigation in a court of competent jurisdiction.)


[ « » ] Litigation in a court of competent jurisdiction.
ARTICLE 7 TERMINATION OR SUSPENSION
§ 7.1 Where the Contract Sum is a Stipulated Sum
§ 7.1.1 The Contract may be terminated by the Owner or the Contractor as provided in Article 14 of AIA Document A232–2009.

§ 7.1.2 The Work may be suspended by the Owner as provided in Article 14 of AIA Document A232–2009.

ARTICLE 8 MISCELLANEOUS PROVISIONS
§ 8.1 Where reference is made in this Agreement to a provision of AIA Document A232–2009 or another Contract Document, the reference refers to that provision as amended or supplemented by other provisions of the Contract Documents.

§ 8.2 Payments due and unpaid under the Contract shall bear interest from thirty (30) days after the date payment is due at the rate stated below, or in the absence thereof, at the legal rate prevailing from time to time at the place where the Project is located.
(Insert rate of interest agreed upon, if any.)

«Six Percent (6%) annually»

§ 8.3 The Owner’s representative:
(Name, address and other information)

«Gerry Mitchell »
«Dayton Metro Library»
«215 East Third Street»
«Dayton, OH  45402»

§ 8.4 The Contractor’s representative:
(Name, address and other information)

« »

§ 8.5 Neither the Owner’s nor the Contractor’s representative shall be changed without ten days written notice to the other party.

§ 8.6 Other provisions:

« »

ARTICLE 9 ENUMERATION OF CONTRACT DOCUMENTS
§ 9.1 The Contract Documents, except for Modifications issued after execution of this Agreement, are enumerated in the sections below.

§ 9.1.1 The Agreement is this executed AIA Document A132–2009, Standard Form of Agreement Between Owner and Contractor, Construction Manager as Adviser Edition.

§ 9.1.2 The General Conditions are, AIA Document A232–2009, General Conditions of the Contract for Construction, Construction Manager as Adviser Edition, as modified and attached hereto as Exhibit F.

§ 9.1.3 The Supplementary and other Conditions of the Contract:

<table>
<thead>
<tr>
<th>Document</th>
<th>Title</th>
<th>Date</th>
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Exhibit G  Safety and Health  113
§ 9.1.4 The Specifications:
(Either list the Specifications here or refer to an exhibit attached to this Agreement.)
«See Exhibit D.»

<table>
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<tr>
<th>Section</th>
<th>Title</th>
<th>Date</th>
<th>Pages</th>
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</table>

§ 9.1.5 The Drawings:
(Either list the Drawings here or refer to an exhibit attached to this Agreement.)
«See Exhibit D.»

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Date</th>
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§ 9.1.6 The Addenda, if any:

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<tr>
<th>Number</th>
<th>As applicable</th>
<th>Date</th>
<th>Pages</th>
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Portions of Addenda relating to bidding requirements are not part of the Contract Documents unless the bidding requirements are also enumerated in this Article 9.

§ 9.1.7 Additional documents, if any, forming part of the Contract Documents are:

.2 AIA Document E201™–2007, Digital Data Protocol Exhibit, if completed, or the following:

« »

.3 AIA Document E202™–2008, Building Information Modeling Protocol Exhibit, if completed, or the following:

« »

.4 Other documents, if any, listed below:
(List here any additional documents which are intended to form part of the Contract Documents. AIA Document A232–2009 provides that bidding requirements such as advertisement or invitation to bid, Instructions to Bidders, sample forms and the Contractor’s bid are not part of the Contract Documents unless enumerated in this Agreement. They should be listed here only if intended to be part of the Contract Documents.)

«The following Exhibits are attached to and made a part of this Agreement:

Exhibit A – Milestone Dates Schedule
Exhibit B – Construction Schedule
Exhibit C – Schedule of Values
Exhibit D – List of Plans and Specifications, Other Documents
Exhibit E – Insurance Requirements
ARTICLE 10  INSURANCE AND BONDS
The Contractor shall purchase and maintain insurance and provide bonds as set forth in Article 11 of AIA Document 2009. (State bonding requirements, if any, and limits of liability for insurance required in Article 11 of AIA Document 2009.)

<table>
<thead>
<tr>
<th>Type of Insurance or Bond</th>
<th>Limit of Liability or Bond Amount ($0.0)</th>
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<tr>
<td>The Insurance Requirements are set forth on Exhibit E attached hereto and made a part hereof.</td>
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</table>

This Agreement is entered into as of the day and year first written above.

DAYTON METRO LIBRARY

CONTRACTOR LEGAL NAME

OWNER (Signature)

CONTRACTOR (Signature)

(Printed name and title)

(Printed name and title)
EXHIBITS

Exhibit A – Milestone Dates Schedule
Exhibit B – Construction Schedule
Exhibit C – Schedule of Values
Exhibit D – List of Plans and Specifications
Exhibit E – Insurance Requirements
Exhibit F – General Conditions
Exhibit G – Safety and Health Management Program
Exhibit H – Sales and Use Tax Construction Contract Exemption Certificate
Exhibit I – Inclusion Plan and Tracking Form
Exhibit J – Bid Manual with Scope of Work/Supply and Clarifications/Qualifications
1. GOVERNING DOCUMENTS

1.1 Where General Conditions are included in the Specifications and where they conflict with the Special Conditions, then the most stringent will govern.

2. SCOPE OF THE WORK - GENERAL

2.1 Each Contractor shall include in their bid all work and incidental work as defined and applicable to the referenced bid package.

2.2 The Contract Documents are intended to represent a complete and fully-operational facility. All support systems and/or components reasonably required and necessary for a complete and operational facility shall be included.

3. PERMITS AND FEES

3.1 Contractor shall pay for and obtain all necessary permits, licenses, and pay all fees associated with the applicable Bid Package. All fines resulting from non-compliance will be the responsibility of the Contractor. The Owner will pay for the general Building Permit.

4. TEMPORARY MEASURES

4.1 Onsite storage is generally not available; Contractors shall use “Just In Time” delivery practices. Material deliveries will be coordinated with CM prior to delivery, and as directed by CM. Any offsite storage of material is the responsibility of the Contractor, all state and local requirements are also the contractor’s responsibility.

4.2 Contractor shall provide its own drinking water, ice, and cups for all trades and visitors onsite.

4.3 Contractor shall provide all protection, safety barricades, devices, covers, etc. as required for the safe conduct of their work and in accordance with the latest OSHA requirements. These measures shall be left in place until authorized to be removed by the CM or authority having jurisdiction. Existing safety measures disturbed by the contractor shall be restored or replaced in full compliance with OSHA standards.

4.4 Contractor shall provide all protection against the elements for the proper execution of its work. Include proper protection of all components and adjacent surfaces that will become a permanent part of the project.

4.5 Temporary Signage is to be included for each branch. Include 10 3’ by 3’ signs with lettering and reflectivity. Metal signs with posts installed. Lettering to be verified with CM prior to fabrication. These are not a part of the temporary signage allowance.

5. ENGINEERING AND LAYOUT

5.1 Contractor shall include all necessary professional engineering including design, certification, and sealing/stamping of design as required by the Bidding Documents.

5.2 Contractor shall include in its Bid all layout, survey work, and engineering as required for its work.
6. DESIGNATED AREAS

6.1 The use of tobacco products of any kind will not be allowed within the confines of the building. Contractor shall police its own employees to ensure compliance with this policy.

6.2 Eating will be allowed only in areas so designated by CM. Designated break areas must be cleaned daily by all contractors.

6.3 All Contractor parking may be off site and is the responsibility of each contractor.

7. MATERIAL DELIVERIES AND STORAGE

7.1 Contractor shall be responsible for proper receiving, unloading, unpacking, handling, distributing, hoisting, rigging, storing, and protection of items to be furnished and/or installed under its Bid Package. All deliveries and storage shall be coordinated with and approved by CM. Materials shall be kept in an orderly and confined area as designated by CM within the construction limits. All material stored on site shall be kept on elevated supports and covered to provide protection from dust, water, mud, snow, and other debris. All materials and/or equipment deemed to be dirty by CM will be cleaned by this Contractor, to the satisfaction of CM prior to its placement inside the building. Contractor agrees to remove same from premises when no longer required for the performance of this work.

7.2 Contractor shall be required to provide its own flag person, traffic control, barricades, protection, and signage as required to assure public and jobsite safety during delivery of materials, supplies, and equipment.

8. SCHEDULES

8.1 Contractor will prepare and maintain an overall Project Construction Schedule. This shall include the initial project schedule with milestones incorporated. The initial project schedule must be provided to the team within 20 days from NTP. This requirement shall include monthly schedule updates with the CM's input.

8.2 Successful Bidders shall complete their work within the specified time for completion. Contractors shall include in their bid sufficient monies to complete their work within the time specified. This may include, but is not limited to: furnishing additional manpower and supervision, expediting materials, working overtime and/or shift work and any other method necessary to complete the project within the scheduled construction time. This shall be accomplished at no increased cost to CM and/or the Owner.

8.3 The successful Bidder shall prepare and submit for approval the following schedules within 20 days of issuance of Contract:

a. CPM Schedule - the successful Bidder's schedule shall agree with the dates set forth in the schedule. Contractor shall provide milestone dates for the delivery of all equipment to be furnished by the Contractor, Owner or others, deemed necessary to support the timely completion of the scheduled work of the Contractor. Contractor's Project Manager shall regularly participate in the updating and maintenance of the schedule.

b. Schedule of Values - to be used for progress payments and based upon the value of work in place plus materials stored. The Schedule of Values will not be approved until the Contractor's CPM Schedule has been approved.

The successful Bidder shall maintain the above schedules for the duration of the project as directed by CM.

8.4 If critical path work cannot be performed during the normal work week, Saturday & Sunday will be used as make-up days at no additional cost to the project or CM.

9. OWNER FURNISHED EQUIPMENT AND MATERIALS

9.1 The Owner reserves the right to procure, under its name and on its forms, equipment and materials. Such equipment and material will be provided to the Contractor for installation in a timely manner to support construction.
10. COORDINATION AND COOPERATION

10.1 Contractor shall coordinate and cooperate with other Subcontractors as necessary to eliminate conflicts with previously installed work and to ensure continuous flow of the work without unnecessary delays, stoppages and damage to work in place by this Contractor and others working in the area. This shall include the placement and/or storage of materials and equipment so as not to interfere with other Subcontractors at any time. Contractor includes re-handling of on-site materials, which interfere with the work of other subcontractors.

10.2 In the event of a dispute arising between contractors over the coordination of the work, CM's ruling will be final and binding on all of the contractors involved.

10.3 Contractor shall assist the testing laboratory in obtaining samples and gathering data as needed relative to its work.

10.4 All communication between Contractor and the Owner and/or Architect/Engineer shall be routed through the Construction Manager Adviser.

11. COORDINATION DRAWINGS

11.1 Coordination drawings showing all horizontal and vertical dimensions of the work shall be prepared by mechanical, plumbing, electrical and fire protection subcontractors as well as others as required or designated by CM. The mechanical contractor shall have primary responsibility for organizing the coordinated drawing effort. This coordination includes above and below ground work of HVAC, plumbing, fire protection and electrical work within five (5) feet of the building line. All other plumbing, mechanical, and electrical contractors are responsible for assisting in developing and maintaining coordination drawings.

11.2 The order of precedence for location above the ceilings is to be as follows: recessed electric light fixtures, plumbing waste and roof drainage, ductwork and above ceiling mounted equipment, electric cable tray, HVAC piping, plumbing piping (domestic water & vent), fire protection, suspended ceilings and electrical conduit.

11.3 All plans (minimum 1/4" scale) and sections (minimum 1/2" scale) shall show building room layouts, structural elements, sprayed fireproofing, pipe with insulation and/or conduit over 1 1/2", racks of more than three (3) pipes or conduit and all ductwork including insulation thickness, regardless of size.

11.4 Coordination meetings will be required and scheduled by CM. The initial meeting will be held prior to the production of any coordination drawings to resolve major interferences. Electronic copies of selected CAD (Computer Aided Design) drawing files with architectural backgrounds shall be requested at this meeting. Prime Contractor is responsible for completing the waivers necessary and paying for the necessary fees to send these files from the design team. Upon completion of the initial ductwork coordination drawings, an electronic version of said drawings will be issued to all other responsible subcontractors for completion within thirty (30) days. After each contractor has fulfilled their obligation it shall return the drawings and electronic files to the mechanical contractor. Coordination drawings will then be submitted to the architect/engineer for review.

11.5 If any Contractor fails to produce all of its initial coordination drawings within the time allocated, CM will produce said drawings, and all costs of producing said drawings will be at the expense of the Contractor.

11.6 Each Contractor designated to contribute information pertinent to the development of the coordination drawings shall attend and participate in the coordination meetings as directed by CM.

11.7 Each Contractor having input into the production of coordination drawings will be required to sign off on acceptance of the final coordination drawings prior to the commencement of its or other participants work in any given area. All costs attributable to failure of a Contractor to provide its timely approval of the coordination drawings or failure to cooperate in the production or assembly of input for said drawings shall be borne by such Contractor.
11.8 CM will determine the method to be used to resolve interference problems not identified prior to execution of the work. The cost of rework and relocations directed by CM will be the responsibility of the Contractor having installed affected items.

11.9 Each Contractor shall review the coordination drawings as directed by CM and shall provide input for updates as may be required.

11.10 Final signed off coordination drawings should be submitted through the submittal review process to the designers. Final format must be CAD, PDF, and color hard copies. Hard copies are to be provided on separate sheets for legibility.

12. JOB STAFF

12.1 Contractor shall provide, at a minimum, a full-time, on-site supervisor acceptable to CM. This supervisor shall be responsible for the coordination of this Contractor’s work with other trades and CM for the duration of this work. Contractor will designate a responsible employee each weekend to be on call in case of emergency work.

12.2 Contractor shall require the jobsite supervisor assigned to the project to attend all weekly Contractor Coordination meetings for the purpose of coordinating the day-to-day activities of the work, and shall submit a revised three week look-ahead schedule to CM each Monday.

12.3 Contractor shall assign a project manager who must attend all meetings scheduled by CM for the purpose of reviewing and updating the CPM schedule, pay requests, change order requests, etc.

12.4 Contractor’s on-site employees will be required to comply with the requirements of CM Safety Program, submitting a daily work report, and Weekly safety meeting information to the CM using the approved forms.

12.5 Contractor shall comply with Owner and Construction Manager Drug testing procedures for working on project.

13. EQUIPMENT

13.1 Contractor shall be responsible for the cost of mobilization and demobilization for all equipment necessary to complete its work, this includes the work associated with, and the understanding there are multiple phases for this project and work may not be concurrent or continuous between phases.

13.2 Contractor shall include the necessary equipment for lifting, hoisting, scaffolding, staging, rigging and materials transport as required within the work of the Bid Package except as noted below. All hoisting shall be executed in accordance with all applicable codes and regulations.

13.3 Contractor shall provide their own telephones and any other necessary means of communication for its employees' use. Each bid package will include a radio/cellular telephones, for its supervisor, that will communicate with CM.

13.4 No music radios will be permitted on the jobsite.

13.5 No two-way communication devices shall be used without verification and approval from CM and the Owner.

14. CLEANING AND PROTECTION

14.1 Contractor shall provide continuous/progressive cleanup necessitated by its operations including daily sweeping of all work areas. Contractor shall provide adequate labor, brooms, shovels, mobile trash containers, carts, buggies and other cleaning equipment to support the quantity of trash and waste generated by this scope of work. All trash and debris shall be deposited in the designated dumpsters on a daily basis. All costs incurred by CM to clean up as a result of this Contractor's failure to clean up will be charged to the Contractor.
14.2 When off-site disposal of debris and/or materials is required by a Bid Package, it shall be done by the Contractor in full compliance with all applicable laws and regulations. Contractor shall bear all costs thereof.

14.3 Contractor generating debris/waste classified as hazardous shall be responsible for the separation of such materials from normal construction debris and the removal/disposal of such materials in full compliance with all applicable laws and regulations.

14.4 Contractor shall remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials from interior and exterior surfaces of fixtures, hardware, finished surfaces and equipment furnished or installed as a part of its Contract.

14.5 Contractor shall take appropriate precautions to prevent damage to any existing work and the work of any other Contractor as may be caused by its actions. Damage which may be caused to another Contractor’s work or existing construction shall be repaired at the damaging Contractor’s own expense and as directed by CM. Claims which may arise as a result of those actions will be handled as set forth in the General Conditions. If CM is unable to determine, to its own reasonable satisfaction, the party responsible for damage to the work then the installing contractor shall repair the damaged work at its own cost.

14.6 Contractor shall provide and maintain protection for the work installed under its Contract as directed by CM.

14.7 Contractor shall be responsible for the final cleaning of its work in a manner that is acceptable by CM.

15. EXISTING CONDITIONS

15.1 Contractor shall check the accuracy of the building structure and/or surface to receive its work and notify CM of any deficiencies prior to beginning its work. Subcontractors shall not proceed with work until unsatisfactory conditions have been corrected and shall not apply work over other Contractor’s incomplete or defective work. Commencement of installation constitutes acceptance of structure and/or base surfaces and the cost of any corrective work due to faulty base surfaces shall be borne by the installer applying its materials thereon.

16. INSTALLED WORK AND SERVICES

16.1 Contractor shall provide and maintain shoring, bracing, underpinning and any other necessary means to protect the existing facilities from collapse or other types of damage until such time as they are to be removed, incorporated into the new work, or can be properly backfilled.

16.2 All Subcontractors shall verify locations of all existing utilities, structures, structural elements, and building services prior to commencing work. All public and private utilities shall be maintained in service at all times except during scheduled shutdowns. Access to fire hydrants shall be maintained at all times. Any damage to utilities or other property by Contractor shall be promptly repaired by Contractor at their cost.

16.3 All work relating to the disruption of existing services shall be performed in accordance with the schedule and be limited to the maximum time specified by CM.

16.4 Contractor shall comply with Owner and Construction Manager background check procedures for working in existing facilities.

17. PADS, CURBS, AND BASES

17.1 All concrete pads, curbs, bases, and miscellaneous concrete required for equipment but not specifically shown on the documents shall be the responsibility of the Contractor installing the equipment.
18. ACCESS PANELS/DOORS

18.1 Contractor shall be responsible for furnishing the necessary access panels for item of work installed under its Contract, including those required by code, regardless of whether or not they are required by the contract documents. If not specified, access panels must be approved by the Architect prior to installation. All access panels to be supplied with a tamper proof locking mechanism.

18.2 Installation of all access panels shall be the responsibility of the Contractor erecting the wall or ceiling system. The trade contractor requiring the access panel will provide it for the contractor erecting the wall or ceiling system.

19. SUBMITTALS & RFI'S

19.1 Contractor shall provide its submittal schedule and material expediting schedule within 10 days of issuance of the Contract for all material and/or equipment necessary to complete their scope of work. All required submittals and shop drawings are required within fifteen (15) days of Notice to proceed with the Work and/or award of this Contract. Provide Electronic copies of all product data, shop drawings, calculations, quality control, etc. Samples & color charts are the only submittal that is required to be hard copy, physical samples. Resubmit any items within a maximum of seven (7) calendar days after being returned for correction. Prime contractor is required to submit these through the submittal process directly to the architect/engineer through a web based interface. This web based interface will be provided to the prime contractor. The prime contractor must copy the CM on all correspondence. The prime contractor must maintain a submittal log and attach to the weekly meeting agenda for discussion.

19.2 In the event that the Contractor or Subcontractor, at any tier, determines that some portion of the Drawings, Specifications, or other Contract Documents requires clarification or interpretation by the Architect, the Contractor shall submit a request for information in writing to the Architect uploaded to the web based interface. This prime contractor is responsible for a RFI log attached to the weekly progress meeting agenda.

19.3 Responses to Requests for Information shall be issued within three (3) working days of receipt of the request from the Contractor unless the Architect determines that a longer time is necessary to provide an adequate response. If a longer time is necessary by the Architect, the Architect will, within one (1) working days of receipt of the request, notify the Contractor of the anticipated response time. If the Contractor submits a Request for Information on an activity with three (3) working days or less of float on the current Project schedule, the Contractor shall not be entitled to any time extension due to the time it takes the Architect to respond to the request provided that the Architect responds within the three (3) working days set forth above.

20. CHANGES IN THE WORK

20.1 Where unit prices are required by the bid forms, they shall include all costs of said work, including overhead and profit. The Contractor’s overhead (5%) and profit (5%) shall not exceed a total of 10% on self-performed work and 5% on Sub-contractor’s work.

20.2 The maximum that will be allowed for overhead, profit, or fee shall be as follows, expressed as a percentage of the actual basic cost of the change:
   a.) For changes to the contractor for work performed with its forces of each – overhead at 5% and profit at 5%.
   b.) To the contractor for work performed by forces other than its own – fee at 5%.

21. CORRECTIVE MEASURES

21.1 CM reserves the right to take whatever action it deems necessary to correct or complete the work of any Contractor failing to perform their work in accordance with the Project Construction Schedule or any other Project Documents or failing to coordinate their work with the work of other subcontractors. All costs incurred by CM in enforcing this provision will be back-charged to the contractor failing to perform.

21.2 Each Contractor is required to complete its work within the time allocated in the Project Construction Schedule as issued herein and as revised and updated through the progress of the work by CM.
Subcontractors failing to comply with this requirement or otherwise delaying the progress shall be liable for all costs incurred as a result of the delay including, but not limited to, all of the costs incurred by CM in accelerating the work of subsequent trades to recover lost time.

21.3 Each Contractor will be required to submit a completed punchlist (performed by the contractor) to CM before final billing is submitted.

22. WORKING HOURS

22.1 Normal working hours will be from 7:00 a.m. until 3:30 p.m., Monday through Friday, or as otherwise directed by CM. Extended hours must be scheduled through CM’s Project Superintendent.

23. REGULATORY REQUIREMENTS

23.1 Each Contractor shall comply with all Federal, State, and Local codes and regulations pertaining to the execution of their work.

23.2 Contractor is responsible for all coordination and scheduling of all inspections and testing services. CM must be notified of all scheduled inspections at least 24 hours in advance. This Contractor also shall submit to CM all inspection reports from local, state, and federal inspection agencies. This Contractor shall be responsible for all costs for re-inspection due to deficiencies of this scope of work.

23.3 Contractor shall attend all local and/or state inspections applicable to this scope of work. This Contractor shall provide the required Supervision and personnel to facilitate these inspections and fully demonstrate the operation of systems installed.

23.4 In the event the Contractor needs to close a street and/or public right-of-way, Contractor will be responsible for permitting, and paying for all costs, if any, of closing the road, street, or right-of-way.

23.5 Contractor shall conform to in all respects to the state, local, and federal guidelines includes preventing the introduction of foreign matter from their operation, including silt and construction waste runoff, into public and private sewers and drainage ways. Any repair and/or cleanup of sewers or drainage ways necessitated by Contractor's operations shall be its responsibility.

23.6 Contractor will comply with all jurisdictional requirements for employee taxes, and company & employee licensing.
Insurance Requirements

Subcontractor = Contractor = Single Prime/GC

Before any work is performed hereunder, it is required that the Subcontractor shall furnish to the Contractor and maintain in force for the duration of this Agreement the kinds of and levels of insurance specified in this article.

The Subcontractor shall carry public liability insurance, in the amounts specified in this article, protecting the Subcontractor against liability or injury to persons or property, happening in connection with the Work and also Worker’s Compensation Insurance, covering the employees engaged in the performance of the Work with companies satisfactory to the Contractor or by state or government insurance, as the case may be, and to deliver copies of the policies to the Contractor upon demand. Subcontractor’s insurer(s) shall have an A.M. Best Rating of A- VII or higher.

Subcontractor shall be liable to pay directly or reimburse the Contractor for the amount of any insurance deductible applicable to a claim or loss caused by the Subcontractor, its directors, officers, employees, agents, licenses and sub-subcontractors and covered by insurance provided by the Contractor or the Owner. In the event two or more parties cause such a loss, the deductible will be prorated in the same proportion as their degree of responsibility for the covered loss.

Before commencing work, Subcontractor shall obtain at its own expense and agrees to keep in effect during the life of the contract and for a period of two (2) years following the completion of the Project, the following insurance through a company or companies acceptable to the Owner, Architect, Engineer and Contractor.

A) Worker’s Compensation and Occupational Disease Insurance must meet the statutory requirements of the State in which work is to be performed.

B) Employer’s Liability: Bodily Injury by Accident – Each Accident Limit $1,000,000
   Bodily Injury By Disease – Policy Limit $1,000,000
   Bodily Injury by Disease – Each Employee $1,000,000

C) Commercial General Liability Insurance with limits of:
   Occurrence Limit $2,000,000
   General Aggregate Limit (Per project Basis) $2,000,000
   Products and Completed Operations
      Aggregate Limit $2,000,000
   Personal and Advertising Injury Limit $1,000,000
   Medical Payments Limit $5,000
   Fire Damage Liability Limit $100,000

D) Automobile Liability on per accident basis covering all owned, non-owned, hired, leased and borrowed automobiles (per accident): $1,000,000

E) Umbrella Excess Liability (over primary insurance): $5,000,000

F) Environmental Liability Insurance: $N/A

G) Other (specify) _________________: $N/A

This insurance shall be on an occurrence basis, (Environmental Liability Insurance or Professional Liability Insurance excepted) and shall protect the Contractor against liability arising from the Subcontractor’s operations and operations by lower tier subcontractors. If the Contract Documents require higher limits, the limits specified in the Contract Documents shall control. Subcontractor’s insurance will cover materials acquired for incorporation into or use at the Project Site, notwithstanding that such materials may not be stored at the Project Site.

Subcontractor is required to furnish an insurance certificate in accordance with the attached sample. In addition to a completed certificate, a copy is required of the endorsement to Subcontractor’s policies adding the additional insureds and making Subcontractor’s coverage primary. All insurance policies shall not be changed or cancelled except upon thirty (30) days’ prior written notice to Contractor.

The Subcontractor’s commercial general liability and any excess / umbrella coverage shall be primary without right of contribution by any insurance carried by certificate holder and / or the additional insureds named.

Contractor and Owner shall be additional insureds on Subcontractor’s general liability and excess / umbrella coverage for operations coverage in accordance with ISO form CG 20 10 10 01 or CG 20 33 10 01, or their equivalents. Contractor and Owner shall also be additional insureds on Subcontractor’s general liability and excess / umbrella coverage for completed operations in accordance with ISO form CG 20 37 10 01 or its equivalent.
Subcontractor shall attach a copy of proposed equivalent additional insured forms to its Certificate of Insurance for review by Contractor.

Subcontractor’s General Liability Insurance shall include coverage for Electronic Data Liability per ISO endorsements CG 04 37 or CG 00 65 or their equivalents.

The Subcontractor’s policy or policies of insurance shall include an insurer’s waiver of subrogation rights in favor of Contractor and Owner.

Evidence of insurance coverage’s in the form of a Certificate of Insurance shall be furnished to the Contractor naming Contractor and Owner as an additional insureds before Subcontractor begins work.
PART 1 - GENERAL

1.01 WORK INCLUDED

A. The milestone schedule represents critical dates that must be met in order to finish by the final project completion date. The contractor shall plan for the necessary resources to achieve these dates. Upon notice to proceed, the overall project CPM schedule will be prepared in accordance with construction schedules. This CPM schedule will list the sequencing and duration of each specific work activity.

B. The submissions of shop drawings, product data and samples is critical to the timely completion of the various phases of the project, and as such, each contractor is responsible to make the required submissions as necessary to allow for reasonable review time and obtain the materials required to complete the work by the specified completion dates. All contractors shall comply with the following submittal requirements.

Submission deadlines for shop drawings are based on their relative impact on the construction schedule. The following represents the category distribution for shop drawings corresponding to the milestone construction schedule below.

C. In the event that a milestone is not met, responsible contractor’s retainage on their applications for payment may be increased until the milestone is satisfactorily met.

1.02 SCHEDULE OF MILESTONES

<table>
<thead>
<tr>
<th>Activity</th>
<th>Dates</th>
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<tbody>
<tr>
<td>Notice to Proceed</td>
<td>October 10, 2017</td>
</tr>
<tr>
<td>Mobilize &amp; Begin Work Onsite</td>
<td>October 23, 2017</td>
</tr>
<tr>
<td>Temporary/Permanent Enclosure</td>
<td>April 20th, 2018</td>
</tr>
<tr>
<td>Start-up HVAC Equipment</td>
<td>May 18th, 2018</td>
</tr>
<tr>
<td>Ready for Punchlist</td>
<td>August 3rd, 2018</td>
</tr>
<tr>
<td>Occupancy Permit</td>
<td>August 17th, 2018</td>
</tr>
<tr>
<td>Project Complete</td>
<td>August 24th, 2018</td>
</tr>
</tbody>
</table>

END OF SECTION
Dayton Metro Library – Segment III

SITE GUIDELINES

Safety

1. All contractors are to conduct Weekly Tool Box Talks and provide a copy of the material covered to the General Contractor/Construction Manager by 9:00am the following day. Daily pre task plans are to be completed and signed by every crew member daily, these are to be turned in by 8am each day.

2. Clean up trash daily. Lunch and break in designated areas only. Smoking is prohibited on facility property.

3. Intoxicating beverages & drugs either possession or use, before or during working hours are strictly forbidden.

4. Hard hat, reflective vests/shirts and safety glasses will be worn 100% of the time by all employees including truck drivers/delivery personnel.

5. All OSHA regulations are to be followed, including the 6 foot fall protection rule.

6. Fall Protection is required for all work being performed 6 foot or more above the working surface or above any unprotected hazard regardless of height.

7. All workers must be properly dressed for the work on site. Shorts, tank tops, tennis shoes, loose jewelry, removal of shirt, or torn clothing are not permitted.

8. Confined space entry is prohibited without the permission of your supervisor. See the company’s “Permit Required Confined Space Program.”

9. All accidents and injuries must be reported immediately to construction manager with written follow-up.

10. All welding and cutting must have a fire watch posted.

11. All fire exits must be maintained unless prior permission is authorized for closing.

12. Storage of flammable/hazardous items must have proper designated storage areas and all MSDS information copied to Shook Construction Company.

13. Each contractor will fill out chemical inventory sheets on a monthly basis and provide a copy to the Construction Manager.

14. Glass bottles and containers are prohibited on this site.

15. Excavations and trenches:
   
   A. Inspection of the excavation or trench, adjacent areas, and protective systems must be made by a competent person daily or as required by changing conditions before employees are permitted to enter the excavation or trench.

   B. No employee is to enter a trench that is four feet or more in depth unless it is in stable rock or is protected by one of the following means: sloped (laid back), shored, sheeted, boxed, or by an engineered system designed to prevent cave-in.
C. An access / egress ladder will be placed in all trenches 4 or more foot in depth and shall not be more than 25 feet from those employees working in the trench.

16. Floor openings shall immediately be:
   A. Covered, secured and clearly marked as “Floor Opening”, or
   B. Protected by a standard guard rail system.

17. Tools shall be operated by authorized personnel, with guards furnished by the manufacturer and “in place.”
   A. Electric Powered Tools: shall be plugged into a circuit that is positively grounded or is protected by a ground fault circuit interrupter. Tools and cords are to be inspected for damage prior to use.
   B. Hand Tools: shall not be used for any other purpose than that intended, and all damaged and worn parts are to be promptly repaired and/or replaced.
   C. Powder Actuated Tools: shall be used by qualified personnel who have been instructed and trained in their safe use and only in areas approved in advance by the Construction Manager.

18. Good Housekeeping shall be practiced on all projects. Walkways, stairways, ladder accesses, shall be kept clear of debris and rubbish.

19. Nails shall be turned down or removed from lumber.

20. Hearing protection shall be worn when exposed to noise hazards.

21. Access ladders shall have side rails extending three feet above the landing area and shall be securely fastened. The ladder feet shall be placed on a substantial base. The area around the top and bottom of the ladder shall be kept clear of debris and materials.

22. Tag lines shall be used when raising or hoisting material or equipment.

23. Compressed gas cylinders must be stored upright, secured, capped and separated.

24. Hazardous materials information on specific hazardous materials used on this project by the company is available to its employees upon request. Material Safety Data Sheets will be maintained in the jobsite offices.

25. Hazardous material removal by company employees is forbidden. If hazardous material is encountered or is suspected, notify your supervisor immediately.

26. Hoisting of personnel on heavy equipment by unapproved methods is prohibited. Riding on a crane hook/ball or on a load will result in the dismissal of the rider and the operator.

27. Report any violations of the safety rules to your immediate supervisor for correction, including any hazards not specifically listed herein.

28. All posted safety rules shall be obeyed and shall not be removed except by management’s authorization.

29. All certifications for equipment operation, welding, safety, etc. are to be turned in on site prior to or concurrently with the start of work on site by all employees.
General Requirements

1. Jobsite work hours are from 7:00 AM to 3:30 PM; Shook Construction Company must be advised of any weekend work or work performed outside of 7:00 AM to 3:30 PM. All activities must be scheduled and approved prior to the start of any work.

2. All construction personnel should be instructed to use common sense and courtesy on site. Abusive language, cat calls, whistling, etc. will not be tolerated.

3. Notify Shook Construction Company of major deliveries 24 hours in advance.

4. See Shook Construction Company concerning use of on-site storage space. Material Storage within the building footprint are limited to those items being installed with two weeks. All other materials must be stored on onsite storage trailers.

5. All contractors are requested to respect in-place work of others. Coordination and cooperation of the various contractors is imperative on this project.

6. All requests for clarification should be in writing to Shook Construction Company.

7. Break and lunch in designated areas only. Smoking is prohibited on facility property.

8. TV’s and radios, including portable devices such as MP3 players, are not permitted except in job trailers. Two-way radios are permitted for the performance of work.

9. Any work performed on site must be attended by a minimum of at least two (2) workers when performed outside of normal working hours. Subcontractor must be on site if any sub tier subcontractors are on site.

10. Each contractor shall prepare a Daily Force and Activity Report on a form approved by Shook Construction Company. This report shall be delivered to Shook Construction Company via email no later than 9:00 AM of the following business day.

11. Emergency, fire and evacuation plans will be posted on site by the general contractor.

12. Demo, underground, earth moving and any other operations that will disturb existing site conditions are not permitted until contractor has properly identified and located all utilities affected by his work. Shook Construction must be informed in advance of these operations and contractor shall have an emergency plan in place prior to the start of any work.

13. All visitors and inspectors must sign in at General Constructor’s jobsite office. It is the contractor’s responsibility to carry out this requirement.

14. Failure to comply with these site guidelines as well as the general provisions and contract documents will be cause for permanent removal from this jobsite.

I, __________________________ (name) of __________________________ (company), have received, read, understand and will comply with the Site Guidelines and will cause these guidelines to be reviewed and complied with by employees and subcontractors under my control.

Signature: __________________________ Date: ____________
FIRM NAME: 

PROPOSAL DUE DATE: 

September 28th, 2017 @ 2pm __________ 

______________________________ 

______________________________ 

TO: Dayton Metro Library

A. The Undersigned, having read the specifications, Notice to Bidders, Instructions to Bidders, General/Supplementary Conditions, and examined the drawings as prepared by Levin Porter Architects, and their design consultants, and likewise having inspected the site of and the conditions affecting and governing the construction of said project, hereby proposes to furnish all material, labor, equipment and services, as specified and described in the said specifications and as shown in the plans, and in compliance with the contract documents, to satisfactorily complete, the bid package work listed below as required for the construction and completion of the DML – West Carrollton Branch.

B. 

<table>
<thead>
<tr>
<th>Bid Package #</th>
<th>Bid Item Description</th>
<th>Total($)</th>
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<tbody>
<tr>
<td>BP 1</td>
<td>Southeast Branch Prime Contractor/GC</td>
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C. The Lump Sum Bid Price includes all insurance premiums required to meet insurance specifications; and includes all applicable sales and/or Use Taxes, permits, and bonds.

D. The above Lump Sum Bid includes all stipulations and requirements of Addenda Number __________ which have been received and accepted by the undersigned.

E. Alternate prices so stated shall be the amount in dollars, which is to be added to, or deducted from, the amount of the base bid price for the bid package. The general provisions of the contract documents shall apply to all work covered by the alternate(s) described herein.

NOTE: All or any combination of the following alternates may be accepted with the base bid in determining the lowest and best bid.

(See Scope of Work for Bid Package Alternate(s) Requirements.)
F. Unit Prices – In the event the Scope-of-Work changes per request of Owner, Architect or GC, and the following items of work are added to or deducted from quantities required by the contract documents, the following unit prices will apply as agreed upon. These unit prices shall include all labor, materials, equipment, freight, tools, installation, supervision, overhead, taxes and profit required for a complete installation. See Unit Price Section under TAB 10 for Unit Price(s) Requirements. As the scope reads, these quantities should be included in the base bid amount with the unit prices identified below.

   $/CY _______________

G. The Undersigned hereby warrants that all subcontractors and suppliers of work and/or material to him have been advised that no substitutions will be considered for proprietary brands specified other than those listed on the Substitution Sheet and authorized prior to award of contract or listed in Addenda.

H. Time of Completion – Each Trade Contractor is to coordinate the sequencing of work and provide necessary shift staffing and overtime premium necessary to meet the completion dates indicated in the project schedule.

I. It is understood and agreed by the undersigned that bids shall not be altered or withdrawn within 60 days from and after the date set forth for receiving bids.

J. The undersigned further agrees that if said bid is accepted, they will enter into a contract with the Owner, using the Owner’s Standard Form of Subcontract/Purchase Order Agreement for the faithful performance of the Bid Package work that is included in the documents.

K. It is also understood and agreed by the Undersigned that the right is reserved by the Construction Manager and/or Owner to accept or reject any and all bids.

L. If no other person or party is interested, state that no person or party other than the bidder is interested in said proposal.
M. Voluntary Alternates

N. Value Engineering Recommendations
All base bids shall be based upon the proprietary brands specified; however, bidders who desire to substitute product(s), materials, equipment or system(s) other than items names in any section, shall list below their proposed substitution(s), and shall show variation(s) (add or deduct) in bid amount that would be caused by acceptance of proposed substitution(s).

<table>
<thead>
<tr>
<th>Spec. Section</th>
<th>Proposed Substitution</th>
<th>Add/Deduct To Base Bid</th>
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PROPOSED SUBCONTRACTORS

Please provide names and brief details of all proposed subcontractors.

<table>
<thead>
<tr>
<th>Subcontractor</th>
<th>Description</th>
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DATE:

STATE OF:

COUNTY OF:

Being of lawful age, being first duly sworn, upon its oath deposes and says:  

That he/she executed the accompanying proposal on behalf of the Contractor there in named, that he/she had lawful authority to do so, said Contractor has not directly or indirectly entered into any agreement, expressed or implied, with any Contractor(s) or person(s), having for its object the controlling of the price or amount of such proposal, or any proposal; the limiting of the number of proposals or contractors; the parceling or farming out of any profits thereof, to any Contractor(s) or other person(s); and further says that he/she has not and will not divulge the sealed proposal to any person whomsoever, except those having a partnership or other financial interest with him/her in said proposal or proposals, until after the sealed proposal or proposals are opened.

Signed:

as:

on behalf of:

(Contractor)

Sworn to and subscribed before me this the day of , 20

(Notary Public)

State of:

County of:

My Commission Expires:
Bid Bond

CONTRACTOR: (Name, legal status and address)

OWNER: (Name, legal status and address)

SURETY: (Name, legal status and principal place of business)

BOND AMOUNT: 10% of bid amount

PROJECT: (Name, location or address, and Project number, if any)

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

Any singular reference to Contractor, Surety, Owner or other party shall be considered plural where applicable.

The Contractor and Surety are bound to the Owner in the amount set forth above, for the payment of which the Contractor and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, as provided herein. The conditions of this Bond are such that if the Owner accepts the bid of the Contractor within the time specified in the bid documents, or within such time period as may be agreed to by the Owner and Contractor, and the Contractor either (1) enters into a contract with the Owner in accordance with the terms of such bid, and gives such bond or bonds as may be specified in the bidding or Contract Documents, with a surety admitted in the jurisdiction of the Project and otherwise acceptable to the Owner, for the faithful performance of such Contract and for the prompt payment of labor and material furnished in the prosecution thereof; or (2) pays to the Owner the difference, not to exceed the amount of this Bond, between the amount specified in said bid and such larger amount for which the Owner may in good faith contract with another party to perform the work covered by said bid, then this obligation shall be null and void, otherwise to remain in full force and effect. The Surety hereby waives any notice of an agreement between the Owner and Contractor to extend the time in which the Owner may accept the bid. Waiver of notice by the Surety shall not apply to any extension exceeding sixty (60) days in the aggregate beyond the time for acceptance of bids specified in the bid documents, and the Owner and Contractor shall obtain the Surety's consent for an extension beyond sixty (60) days.

If this Bond is issued in connection with a subcontractor's bid to a Contractor, the term Contractor in this Bond shall be deemed to be Subcontractor and the term Owner shall be deemed to be Contractor.

When this Bond has been furnished to comply with a statutory or other legal requirement in the location of the Project, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted here from and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. When so furnished, the intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

Signed and sealed this day of

(Witness)

(Principal) (Seal)

(Witness)

(Title)

(Witness)

(Surety) (Seal)

(Witness)

(Surety) (Seal)
1. Included in this section are copies of the following documents:
      i. This plan will give you all the information necessary to understand the intent and definition of the goals.
   b. Commitment To Participate In The DML Inclusion Plan form (note this is also included as part of your bid form).
      i. This form must be submitted with your bid.
   c. Participation Declaration (note this is also included as part of your bid form).
      i. Be prepared, if requested, to submitted this form within 24 hours of bid opening.
   d. Monthly Inclusion Summary
      i. This form will need to be filled out monthly and submitted with your pay application.
   e. A list of potential Inclusion contractors

2. Bidders are encouraged to contact the following organizations during the bidding process to help facilitate participation from certified bidders and can provide additional certified contractors.
   a. Dayton Area Chamber of Commerce, Minority Business Partnership - 937.226.8233
   b. City of Dayton, Human Relations Council, Minority Business Assistance Center - 937.333.1030

3. The post bid interview process will include discussion on the intent from the bidding contractors to meet the goals outlined in the bidding documents.
   a. Scope items below are exempt from the inclusion percentages
      i. Glass/Glazing
      ii. Fire Protection
      iii. Skylights
      iv. Roofing
      v. Structural/Misc. Steel
      vi. Elevators
   b. The PEP goals are only applicable for those branches that are within the City of Dayton.

4. Those bidders NOT MEETING the Inclusion Goals will be required to provide Good Faith Effort documentation within 24 hours of your bid opening. Good Faith Effort may include, but not be limited to:
   a. Detailed documentation of contacts with certified firms, including the firm name, address, telephone number, email address and dates of calls or email and contact results.
   b. Copies of direct solicitation letters sent to all certified firms.
   c. Copies of announcements/postings in the newspaper or other media for specific contracting opportunities.
d. Copies of announcements/postings of contracting opportunities in trade publications or media that target certified firms.

e. Documentation of sources used to identify potential certified firms.

f. Indicate the services or organizations that provided assistance to you in identifying and recruiting certified business that you used in preparing the proposal.

g. List all interested certified firms which you rejected as being unqualified for the work of the contract and provide the reason(s) for the rejections.
Dayton Metro Library
COMMITMENT TO PARTICIPATION
IN THE DML INCLUSION PLAN

The Bidder agrees to comply with or make a good faith effort to comply with the Dayton Metro Library Community Inclusion Plan of enterprise participation goals percent of each Contract award amount, calculated as a portion of the Base Bid plus all accepted Alternates.

COMMITMENT TO COMMUNITY INCLUSION PROGRAM

Project Name and Location: ________________________________
Bidder Company Name: __________________________________
Bidder Company Address: ________________________________
Federal Tax I.D. Number: ____________________ Phone Number: __________
Contact Person: ___________________________ Email Address: __________

This form is required as a condition precedent to contract execution, see Instructions To Bidders.

Bidder Shall Only Mark One Option

___ Option A
Bidder commits to meet or exceed the advertised DML Community Inclusion Participation Goals of the Contract Award Amount, calculated as a portion of the Base Bid plus all accepted Alternates, by using minority Business Enterprise(s).

- Minority Business Enterprises (MBE) 17% (9% MBE PEP certified)
- Women Business Enterprises (WBE) 5% (2% WBE PEP certified)
- Dayton Local Small Business (10% DLSB PEP certified *)
  *For’ Projects located in the City of Dayton
- Montgomery County Business Enterprises 60%
- Local Business Enterprises (LBE) 70%
- Workforce Participation – Minority 12% & Female 7%

___ Option B (also indicate percentage — see text)

Bidder does not meet the advertised Participation Goals of the Contract Award Amount, but if awarded the Contract for this project, commits to providing the following percentages of the Contract Award Amount, calculated as a portion of the Base Bid plus all accepted alternates.

- Minority Business Enterprises (MBE) ___% (___% MBE PEP certified)
- Women Business Enterprises (WBE) ___% (___% WBE ZPEP certified) Dayton Local Small Business (___% DLSB PEP certified *)
  *For’ Projects located in the City of Dayton
- Montgomery County Business Enterprises ___%
- Local Business Enterprises (LBE) ___%
- Minority Workforce ___%
- Female Workforce ___%

For options A or B, Bidder acknowledges that it may be requested to provide within 24 hours of bid opening a Statement of Intent to Contract and Perform (see attached Participation Declaration) for each Business Enterprise(s) proposed for use by the Bidder if awarded the Contract for this Project.

For option B only, Bidder agrees that it shall provide within 24 hours of bid opening a detailed Demonstration of Good Faith describing its efforts undertaken prior to submitting its Bid to meet the advertised Participation Goals.

______________________________
Bidder ____________________________________________
Authorized Representative Name & Title (Print or Type)

______________________________
Signature of Authorized Representative
Dayton Metro Library
Revised Community Inclusion Policy
Resolution

WHEREAS, Dayton Metro Library, a county-wide system consisting of the Main Library in downtown Dayton with branch locations throughout Montgomery County, is one of the oldest and largest public library systems in Ohio, ranking among the best in the nation, and

WHEREAS, the Dayton Metro Library is charged with providing quality service to residents of Montgomery County, and

WHEREAS, voters of the Dayton Metro Library service district overwhelming approved passage of the $187 million “Libraries for a Smarter Future” bond issue to construct, renovate and otherwise improve library facilities, and

WHEREAS, voters and residents have high expectations as to the quality of the library facilities to be constructed and the prudent investment of public funds in our community, and

WHEREAS, it is recognized by the Dayton Metro Library that the construction projects identified will have a significant social and economic impact on the community and its residents, and

WHEREAS, Dayton Metro Library desires to provide leadership in the reinvestment of its locally generated tax funds, and

WHEREAS, Dayton Metro Library is committed to the creation of quality jobs that support a living wage for its residents, and

WHEREAS, it is in the long term interest of the Dayton Metro Library and the community to actively develop and engage in management practices that will produce economic benefits for all of the community’s citizens and business entities, and

WHEREAS, this building program intends to foster internships, apprenticeships and other job training opportunities for youth and young adults, and

WHEREAS, the Dayton Metro Library wishes to state its commitment to equal opportunity and non-discrimination in all aspects of employment and contracting, for both existing programs and future plans, and

WHEREAS, the Dayton Metro Library, through the use of socially conscious and responsible management practices, intends to provide opportunities to actively promote the participation of community members and businesses who have not been given the opportunity
to participate in major economic endeavors thereby contributing to the economic growth of our entire community;

THEREFORE, be it resolved that the Dayton Metro Library hereby establishes a community inclusion plan that places priority on participation by locally owned and Montgomery County owned businesses in the projects funded by the “Libraries for a Smarter Future” program. It is also a priority of the Dayton Metro Library to ensure equal opportunity and participation by minority and women owned businesses. Workforce participation in these projects that represents and reflects the population of the library service district is an additional priority. Every effort will be made to achieve each of the above priority outcomes through its comprehensive community inclusion plan.

Dayton Metro Library
Revised Community Inclusion Plan

The Dayton Metro Library has adopted a “Libraries for a Smarter Future” facilities plan for constructing, renovating and expanding its facilities in four segments. This revised plan, originally adopted in January 2014, for Segment One projects is applicable to all Segment Two projects. This plan and its goals will be applied to remaining segments and may be amended as determined by the Board of Trustees.

In order to concretely achieve the goals and objectives, and aspirations of local, minority and women owned business participation, as stated in the Community Inclusion Policy resolution, the Dayton Metro Library and its Construction Management Advisor (CMA) will adopt the following policies, strategies and procedures:

A. Lowest Responsible Bid

In accordance with Sections 3375.41, 153 and 9.312, of the Ohio Revised Code, the Dayton Metro Library will adopt criteria to determine the lowest responsible bids in awarding contacts. Prime and general bid packages issued by the Dayton Metro Library will outline for prospective bidders specifications for documenting efforts made to include minority owned, women owned and local subcontractors in bid proposals.

B. Prevailing Wages

In accordance with Sections 4115 of the Ohio Revised Code, the Dayton Metro Library District will undertake the establishment of procedures and practices to ensure the proper payment of prevailing wages to employees by contractors and sub-contractors. Certified payroll reports will be required to be submitted and documented as part of every subcontract agreement in accordance with state and local regulations.

C. Local Advertising and Bidding
• Pre-bid advertising and bid solicitation will be limited to contractors and suppliers within the 9 county area defined as the Dayton Community

• An open forum for contractor notification and inclusion will be held by the CMA under contract by Dayton Metro Library to manage the construction phase of projects, to encourage participation of local, minority and women owned contractors.

D. Minority, Women and Local Business Participation

The Dayton Metro Library will partner with the City of Dayton Human Relations Council, Montgomery County, the Minority Business Assistance Center and the Dayton Area Chamber of Commerce Minority Business Partnership to coordinate outreach efforts to meet participation goals.

It is the intent of Dayton Metro Library to meet or exceed the business participation goals set out as follows:

<table>
<thead>
<tr>
<th>Minority Business Enterprises (MBE)</th>
<th>17% (9% MBE PEP certified)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women Business Enterprises (WBE)</td>
<td>5% (2% WBE PEP certified)</td>
</tr>
<tr>
<td>Dayton Local Small Business</td>
<td>(10% DLSB PEP certified*)</td>
</tr>
<tr>
<td><em>For Projects located in the City of Dayton</em></td>
<td></td>
</tr>
<tr>
<td>Montgomery County Business Enterprises</td>
<td>60%</td>
</tr>
<tr>
<td>Local Business Enterprises (LBE)</td>
<td>70%</td>
</tr>
</tbody>
</table>

It is responsibility of the library board, its staff and leadership, its construction managers, and successful bidders and subcontractors to take concrete steps towards achieving the goals outlined above.

Local Business Enterprises are defined as those that include the following 9 county area: Shelby, Darke, Miami, Clark, Preble, Montgomery, Greene, Butler, and Warren.

Minority Business Enterprises are recognized as those certified within the MBE/EDGE Program of the Ohio DAS or other certifying agencies that may be recognized by the Dayton Metro Library.

Women Business Enterprise certifications include any WBENC affiliate (Women’s Business Enterprise National Council) or other certifying agencies that may be recognized by the Dayton Metro Library.
MBE, WBE and DLSB Procurement Enhancement Program (PEP) certified companies are small business enterprises certified by the City of Dayton at the time of award.

A certified MBE or WBE shall not be counted toward both the MBE and WBE goals, only one or the other. Otherwise, a company can count towards all goals for which they are qualified/certified.

Work performed by qualifying but uncertified MBE, WBE and LBE companies can be counted toward participation goals once successfully certified but only for work completed following certification.

E. Workforce Participation

The Dayton Metro Library will make every effort to ensure worker utilization supports and mirrors the community served by the Library. To that end, it is the intent of the Dayton Metro Library to meet or exceed the workforce participation/utilization goals set out as follows:

<table>
<thead>
<tr>
<th>Category</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minority</td>
<td>12%</td>
</tr>
<tr>
<td>Female</td>
<td>7%</td>
</tr>
</tbody>
</table>

Dayton Metro Library recognizes the importance of making sure that residents benefit from any and all employment and economic opportunities that result from the $187 million bond issue voters approved in November of 2012. Contractors, subcontractors, developers, and/or sub-recipients are likewise expected by Dayton Metro Library to demonstrate in their hiring plan and through their subsequent implementation actions at residents are included in the hiring goals and are indeed beneficiaries of employment opportunities resulting from contract awards. The following hiring goals apply to all projects associated with the “Libraries for a Smarter Future” facilities plan for constructing, renovating and expanding facilities in the four segments:

Employment: Twenty percent (20%) of the aggregate number of new hires during a one year period of the project. (Example: A construction contractor hires 10 new workers. Two of the new workers should be hired based on the priorities below.)

- Tier 1: Community where project is taking place
- Tier 2: City where project is taking place
- Tier 3: County where project is taking place
- Tier 4: Nine county area

F. Apprenticeships and Co-op programs

The Dayton Metro Library will encourage all subcontractors and suppliers bidding the projects to document their policy for the utilization of apprentice and co-op programs to
support employment training for local youth. Bid evaluations will be subject to the good faith effort put forth by all bidders to accomplish this objective.

G. Availability of Contractors

It is the overall intent and objective of this plan to prioritize the utilization of local, minority and women owned contractors to build the “Library for a Smarter Future” projects within the budget limitations established for each project.

Under this plan it is understood that for some specific bid packages there may not be a sufficient number of qualified local, women and/or minority owned contractors to bid the scope of work defined. This can only be determined after all of the following criteria have been evaluated and fully implemented in accordance with this plan.

A. A broad scope advertising effort has been completed

B. A community outreach open forum has been solicited and publicly open to all interested bidders

C. Input from local business leaders, contractor associations (both union and non-union) and from MBE institutions and agencies has been provided to the CMA under contract to Dayton Metro Library to manage the construction phase of the project

Should it be determined that there is a deficiency in the availability of qualified local and minority contractors (less than four total bidders for a specific bid package), the solicitation of bidders for specific bid packages may extend beyond the 9 county areas defined as the Dayton Community.

For the purposes of tracking success in achieving the above Business Participation goals, the scope of projects will be inclusive of construction bid packages and procurements where MBE and WBE and LBE bidders and contractors have participated.

Under this plan, it is understood that the achievement of participation goals for locally owned and minority owned business may be conflicting under certain circumstances. It is the intent of Dayton Metro Library to place priority on local contractor participation should an imbalance occur.

H. Reporting and Monitoring

During the preconstruction, bidding and award phases, the Dayton Metro Library will provide sub-contractor and worker utilization reports to Montgomery County, the City of Dayton, the Minority Business Partnership and the community at large. Worker
utilization reports can be substituted with payroll reports specific to the project. During construction, reports will be provided no less than quarterly.

The Dayton Metro Library will work with the City of Dayton Human Relations Council, Minority Business Partnership and Montgomery County to establish reporting requirements for contractor participation. Reporting requirements will be included in all bid solicitations.

F. Anti-Discrimination

The Dayton Metro Library and its contractors will not discriminate against any employee or applicant for employment because of race, color, religion, sex, national origin, ancestry, place of birth, age, marital status, sexual orientation, gender identity, or disability. The Dayton Metro Library and its contractors will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, national origin, ancestry, place of birth, age, marital status, sexual orientation, gender identity, or disability. Such action shall include, but not be limited to the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Dayton Metro Library and its contractors agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the contracting officer setting forth the provisions of this nondiscrimination clause.

The Dayton Metro Library and its contractors will, in all solicitations or advancements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to their race, color, religion, sex, national origin, ancestry, place of birth, age, marital status, sexual orientation, gender identity, or disability.

It is understood that the employee must be able to perform the duties of the job in which the individual is applying.
**Participation Declaration**

*(To Be Submitted Within 24 Hours of Bid Submission)*

Dayton Metro Library Segment 2 - Inclusion Tabulation Sheet

<table>
<thead>
<tr>
<th>Name of Certified Sub/Supplier</th>
<th>Scope of Work</th>
<th>MBE</th>
<th>Dollar Amt.</th>
<th>WBE</th>
<th>Dollar Amt.</th>
<th>DLSB PEP</th>
<th>Dollar Amt.</th>
<th>MCBE</th>
<th>Dollar Amt.</th>
<th>LBE</th>
<th>Dollar Amt.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

**Total Bid Amount:** $0.00

**Dollar Amount**

- MBE Bid Amount: $0.00 
- WBE Bid Amount: $0.00 
- DLSB PEP Bid Amount: $0.00 
- MCBE Bid Amount: $0.00 
- LBE Bid Amount: $0.00 

**Bidder:**

Authorized Representative Name & Title (Print or Type)

---

Signature of Authorized Representative
### Monthly Inclusion Summary

**Project Number:**

<table>
<thead>
<tr>
<th>Scope of Work</th>
<th>DEE Function</th>
<th>Cost Allocation</th>
<th>Inclusive Data</th>
<th>Firm</th>
<th>Total Adjusted Contract</th>
<th>M/F</th>
<th>Minority/Female</th>
<th>Hours</th>
<th>% Minority</th>
<th>% Female</th>
</tr>
</thead>
</table>

#### Legend

- WBE: Women-Owned Business Enterprise
- SBE: Small Business Enterprise
- PEP: Program Enhancement Program
- MBE: Minority Business Enterprise
- DLSE: Dayton Local Small Business (the projects located in City of Dayton)
- DDEE: Disadvantaged Business Enterprise
- UK: Local Business Enterprise of County Region (Kings, Shelby, Darke, Miami, Clermont, Montgomery, Greene, Butler, and Warren)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Goal %</th>
<th>Current %</th>
<th>Percent from Goal</th>
<th>Award</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBE % Goal</td>
<td>8.00%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WBE M/F % Goal</td>
<td>5.00%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WBE % Goal</td>
<td>2.00%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WBE M/F % Goal</td>
<td>2.00%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Local Participation**

<table>
<thead>
<tr>
<th>M/F</th>
<th>Minority/Female</th>
<th>Hours</th>
<th>% Minority</th>
<th>% Female</th>
</tr>
</thead>
</table>

<p>| Workforce Participation: Minority % Goal | 12.00% |
| Workforce Participation: Female % Goal | 1.00% |</p>
<table>
<thead>
<tr>
<th>Company</th>
<th>Address</th>
<th>City</th>
<th>State</th>
<th>Zip</th>
<th>Phone</th>
<th>Fax</th>
<th>Nature of Business</th>
<th>Diversity</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>21st Century Concrete</td>
<td>13095 Enterprise Avenue</td>
<td>Cleveland</td>
<td>OH</td>
<td>44135</td>
<td>216-362-0900</td>
<td>216-362-0955</td>
<td>03 - Concrete Placement</td>
<td>SBE</td>
<td><a href="mailto:jeff@21stccc.co">jeff@21stccc.co</a></td>
</tr>
<tr>
<td>2D Construction LLC</td>
<td>365 Helen Drive</td>
<td>Vermilion</td>
<td>OH</td>
<td>44080</td>
<td>440-963-0233</td>
<td>440-963-0234</td>
<td>03 - Concrete Placement, 02 - Site Concrete</td>
<td>SBE</td>
<td><a href="mailto:mike@2dconstruction.com">mike@2dconstruction.com</a></td>
</tr>
<tr>
<td>JNT</td>
<td>531 E. Third Street</td>
<td>Dayton</td>
<td>OH</td>
<td>45402</td>
<td>888-705-5251</td>
<td>888-652-7331</td>
<td>01 - Testing and Inspection</td>
<td>MBE SBE</td>
<td><a href="mailto:manual.jacobs@jnteng.com">manual.jacobs@jnteng.com</a></td>
</tr>
<tr>
<td>A &amp; D Contracting, Inc.</td>
<td>3620 Pearl Road</td>
<td>Cleveland</td>
<td>OH</td>
<td>44119</td>
<td>216-749-8600</td>
<td>216-749-8610</td>
<td>02 - Demolition, Remediation</td>
<td>EDGE WBE FBE SBE</td>
<td><a href="mailto:adcon8810@aol.com">adcon8810@aol.com</a></td>
</tr>
<tr>
<td>A&amp;A Wall Systems, Inc.</td>
<td>11569 Deerfield Rd.</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45242</td>
<td>513-489-0096</td>
<td>513-489-0544</td>
<td>09 - Acoustic Ceiling, Drywall</td>
<td>WBE</td>
<td><a href="mailto:paulsysystems@gmail.com">paulsysystems@gmail.com</a></td>
</tr>
<tr>
<td>A. L. Miller Plumbing Inc.</td>
<td>609 Nortykne Road</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45255</td>
<td>513-474-4915</td>
<td>513-474-4915</td>
<td>15 - Plumbing</td>
<td>SBE</td>
<td><a href="mailto:millerplbg@swohio.twcbc.com">millerplbg@swohio.twcbc.com</a></td>
</tr>
<tr>
<td>Able Fence &amp; Guard Rail</td>
<td>2779 East 4th Avenue</td>
<td>Columbus</td>
<td>OH</td>
<td>43219</td>
<td>614-253-8587</td>
<td>614-253-8598</td>
<td>02 - Fence</td>
<td>WBE</td>
<td><a href="mailto:michael@ablefencedcolumbus.com">michael@ablefencedcolumbus.com</a></td>
</tr>
<tr>
<td>ACS Contractors</td>
<td>5320 Bagley Road</td>
<td>Columbus</td>
<td>OH</td>
<td>43232</td>
<td>740-524-7600</td>
<td>740-924-6281</td>
<td>02 - Fence</td>
<td>WBE SBE EDGE</td>
<td><a href="mailto:estimating@excontractors.com">estimating@excontractors.com</a></td>
</tr>
<tr>
<td>Advanced Caulking, LLC</td>
<td>5 North Commerce Park Dr., Ste D</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45215</td>
<td>513-528-4285</td>
<td>513-528-1937</td>
<td>07 - Waterproofing and Joint Sealants</td>
<td>WBE EDGE SBE</td>
<td><a href="mailto:email@advancedcaulking.com">email@advancedcaulking.com</a></td>
</tr>
<tr>
<td>Advanced Federated Protection Inc.</td>
<td>1991 Lee Road</td>
<td>Cleveland Heights</td>
<td>OH</td>
<td>44118</td>
<td>216-321-1369</td>
<td>216-321-1392</td>
<td>10 - Specialists</td>
<td>MBE SBE</td>
<td>ste644东亚@east.com</td>
</tr>
<tr>
<td>Aero Mechanical Systems, Inc.</td>
<td>416 Winton Avenue</td>
<td>Dayton</td>
<td>OH</td>
<td>45403</td>
<td>(317) 254-9202</td>
<td>(317) 254-9208</td>
<td>15 - HVAC &amp; Plumbing</td>
<td>DBE UCP</td>
<td>hvac@aeromechanicalbio</td>
</tr>
<tr>
<td>Air Rite Service Supply</td>
<td>1200 West 117th Street</td>
<td>Cleveland</td>
<td>OH</td>
<td>44107</td>
<td>216-228-8200</td>
<td>216-228-5651</td>
<td>15 - HVAC</td>
<td>SBE</td>
<td><a href="mailto:dina@airrite-supply.com">dina@airrite-supply.com</a></td>
</tr>
<tr>
<td>AKA Construction Management Team, Inc.</td>
<td>4640 Hinsley Industrial Parkway</td>
<td>Cleveland</td>
<td>OH</td>
<td>44100</td>
<td>216-751-2000</td>
<td>216-751-2000</td>
<td>07 - Waterproofing and Joint Sealants</td>
<td>MBE WBE SBE</td>
<td><a href="mailto:bruce@akateam.com">bruce@akateam.com</a></td>
</tr>
<tr>
<td>AKA Construction, Inc.</td>
<td>PO Box 13116, 4325 Webster St.</td>
<td>Dayton</td>
<td>OH</td>
<td>45431</td>
<td>507-222-1501</td>
<td>507-276-5200</td>
<td>01 - GC; 03 - Concrete Placement; 08 - Door Install</td>
<td>EDGE DBE UCP WBE SBE</td>
<td><a href="mailto:amy@aka-construction.com">amy@aka-construction.com</a></td>
</tr>
<tr>
<td>Akron Rebar Co (Akron Erectors)</td>
<td>805 West Waterlo Rd.</td>
<td>Akron</td>
<td>OH</td>
<td>44314</td>
<td>330-745-7100</td>
<td>330-745-7272</td>
<td>03 - Reinforcing Steel Install &amp; Supply</td>
<td>SBE</td>
<td><a href="mailto:joshrei@akronrebar.com">joshrei@akronrebar.com</a></td>
</tr>
<tr>
<td>ALC Flooring Systems LLC</td>
<td>617 Indiana Avenue, Suite 315</td>
<td>Indianapolis</td>
<td>IN</td>
<td>46202</td>
<td>317-353-8590</td>
<td>317-784-0212</td>
<td>09 - Flooring</td>
<td>MBE</td>
<td></td>
</tr>
<tr>
<td>All Aspects Contracting</td>
<td>2800 Euclid Avenue</td>
<td>Cleveland</td>
<td>OH</td>
<td>44115</td>
<td>440-315-0094</td>
<td>440-385-0930</td>
<td>02 - Demolition</td>
<td>DBE SBE WBE EDGE</td>
<td><a href="mailto:allaspectcon@hotmail.com">allaspectcon@hotmail.com</a></td>
</tr>
<tr>
<td>All Ohio Sealants Inc.</td>
<td>4311 Bellwood Drive</td>
<td>NW Canton</td>
<td>OH</td>
<td>44708</td>
<td>216-353-0585</td>
<td>216-452-6591</td>
<td>07 - Waterproofing and Joint Sealants</td>
<td>VOB</td>
<td><a href="mailto:ksha@allohiosealants.com">ksha@allohiosealants.com</a></td>
</tr>
<tr>
<td>Alliance Millwork &amp; Mfg., LLC</td>
<td>5931 Wolf Creek Pike</td>
<td>Trotwood</td>
<td>OH</td>
<td>45426</td>
<td>507-259-7571</td>
<td>507-259-3417</td>
<td>06 - Millwork</td>
<td>WBE</td>
<td><a href="mailto:info@allianceom.com">info@allianceom.com</a></td>
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<tr>
<td>Allied Fence Builders, Inc.</td>
<td>1644 Kuntz Road</td>
<td>Dayton</td>
<td>OH</td>
<td>45404</td>
<td>507-226-0311</td>
<td>507-226-0347</td>
<td>02 - Fence</td>
<td>WBE</td>
<td><a href="mailto:bill@affived-fence.com">bill@affived-fence.com</a></td>
</tr>
<tr>
<td>Alternale Electric Inc.</td>
<td>4171 Lindon Circle</td>
<td>North Olmsted</td>
<td>OH</td>
<td>44115</td>
<td>440-777-7800</td>
<td>440-777-7878</td>
<td>16 - Electrical</td>
<td>MBE WBE SBE</td>
<td><a href="mailto:gromco@alternalelectric.com">gromco@alternalelectric.com</a></td>
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<td>13311 Enterprise Ave.</td>
<td>Cleveland</td>
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<td>44135</td>
<td>216-267-9100</td>
<td>216-267-9113</td>
<td>14 - Conveyance Systems</td>
<td>SBE</td>
<td><a href="mailto:karen@amcranehost.com">karen@amcranehost.com</a>, <a href="mailto:kevin@amcranehost.com">kevin@amcranehost.com</a></td>
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<td>America Coring &amp; Sawing Inc.</td>
<td>365 Helen Drive</td>
<td>Vermilion</td>
<td>OH</td>
<td>44080</td>
<td>600-632-2187</td>
<td>440-967-0526</td>
<td>03 - Concrete Coring and Sawing</td>
<td>SBE</td>
<td><a href="mailto:abbey@americoring.com">abbey@americoring.com</a></td>
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<tr>
<td>Amico / Seasafe</td>
<td>202 Glasser Drive</td>
<td>Lafayette</td>
<td>LA</td>
<td>70508</td>
<td>800-326-8842</td>
<td>327-833-2770</td>
<td>06 - FPR</td>
<td>WBE</td>
<td><a href="mailto:gilbreri@gilbreri1.com">gilbreri@gilbreri1.com</a></td>
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<td>AMI Construction Inc.</td>
<td>4135 East 142nd Street</td>
<td>Cleveland</td>
<td>OH</td>
<td>44128</td>
<td>216-470-8663</td>
<td>216-283-9500</td>
<td>02 - Demolition</td>
<td>MBE SBE</td>
<td><a href="mailto:amiconstruction@ahbyglobal.net">amiconstruction@ahbyglobal.net</a></td>
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<td>Apex Mechanical Systems inc.</td>
<td>453 E. Wenger Rd.</td>
<td>Englewood</td>
<td>OH</td>
<td>45322</td>
<td>507-836-8200</td>
<td>507-836-6221</td>
<td>15 - HVAC &amp; Plumbing</td>
<td>EDGE WBE SBE</td>
<td><a href="mailto:apex@apexmechsys.com">apex@apexmechsys.com</a></td>
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**Table Columns:**
- **Company**
- **Address**
- **City**
- **State**
- **Zip**
- **Phone**
- **Fax**
- **Nature of Business**
- **Diversity**
- **Email**
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<td>7632 Depot Road</td>
<td>Ashtabula</td>
<td>OH</td>
<td>44004</td>
<td>440-983-9650</td>
<td>440-956-0950</td>
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<td><a href="mailto:arcforceind@aol.com">arcforceind@aol.com</a></td>
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<td>Armcorp Construction Inc.</td>
<td>8511 St. Ri. 703</td>
<td>Celina</td>
<td>OH</td>
<td>44022</td>
<td>419-778-7024</td>
<td>419-778-7084</td>
<td>13 - Metal Buildings; 02 - Selective Demo</td>
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<td><a href="mailto:tim@armcorpgroup.com">tim@armcorpgroup.com</a></td>
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<td>Aircraft Sand and Gravel Co., Inc.</td>
<td>5850 Dry Fork Road</td>
<td>Cleves</td>
<td>OH</td>
<td>44022</td>
<td>513-367-5700</td>
<td>513-367-0824</td>
<td>02 - Aggregates</td>
<td>SBE</td>
<td><a href="mailto:aslerp@asler.com">aslerp@asler.com</a></td>
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<tr>
<td>ASI - Signage Innovations</td>
<td>2300 Meadow Drive Suite 202</td>
<td>Louisville</td>
<td>KY</td>
<td>40218</td>
<td>502-473-4715</td>
<td>502-473-4716</td>
<td>10 - Signage</td>
<td>WBE</td>
<td><a href="mailto:km.moscarino@asisignage.com">km.moscarino@asisignage.com</a></td>
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<tr>
<td>Aster Elements</td>
<td>7100 Euclid Avenue</td>
<td>Cleveland</td>
<td>OH</td>
<td>44103</td>
<td>440-942-2799</td>
<td>440-942-5189</td>
<td>07 - Roofing and Sheet Metal</td>
<td>MBE/SBE</td>
<td><a href="mailto:asterp@aster.us">asterp@aster.us</a></td>
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<tr>
<td>Avenue Fabricating, Inc.</td>
<td>1381 Clough Pike</td>
<td>Bexley</td>
<td>OH</td>
<td>45101</td>
<td>513-752-1811</td>
<td>513-752-0044</td>
<td>05 - Steel &amp; Metals</td>
<td>DBE WBE</td>
<td><a href="mailto:avenuefab@avenuefabricating.com">avenuefab@avenuefabricating.com</a></td>
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<tr>
<td>Azcon Flooring Enterprises, LLC</td>
<td>8216 Princeton-Glendale RD #158</td>
<td>West Chester</td>
<td>OH</td>
<td>45069</td>
<td>513-645-2380</td>
<td>513-645-4270</td>
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<tr>
<td>Aztec Electric Inc.</td>
<td>702 Brown St.</td>
<td>Dayton</td>
<td>OH</td>
<td>45420</td>
<td>937-313-9556</td>
<td>937-225-0805</td>
<td>16 - Electrical</td>
<td>DLB MBE DBEUPC</td>
<td><a href="mailto:dayton@aztecelectric.com">dayton@aztecelectric.com</a></td>
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<td>B &amp; B Wrecking &amp; Excavating</td>
<td>4510 East 71st St. Suite 6</td>
<td>Cleveland</td>
<td>OH</td>
<td>44105</td>
<td>216-429-1700</td>
<td>216-429-1717</td>
<td>02 - Demolition</td>
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<td><a href="mailto:nick@bbwreck.com">nick@bbwreck.com</a></td>
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<td>19501 S. Miles Rd. Suite 2</td>
<td>Warrenville</td>
<td>OH</td>
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<td>216-662-2406</td>
<td>216-587-9458</td>
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<td>Barbicas Construction Company</td>
<td>124 Darrow Road</td>
<td>Akron</td>
<td>OH</td>
<td>44305</td>
<td>330-733-9101</td>
<td>330-733-9651</td>
<td>02 - Paving, Silework; 03 - Concrete Placement</td>
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<td><a href="mailto:carla@barbicason.com">carla@barbicason.com</a></td>
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<tr>
<td>Barn &amp; Prevost</td>
<td>531 East 3rd Street</td>
<td>Dayton</td>
<td>OH</td>
<td>45402</td>
<td>937-435-3020</td>
<td>937-291-5849</td>
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<td><a href="mailto:eoghan.prevost@barreng.com">eoghan.prevost@barreng.com</a></td>
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<tr>
<td>Biosource</td>
<td>869 US 68 South</td>
<td>Xenia</td>
<td>OH</td>
<td>45385</td>
<td>937-604-9864</td>
<td>937-372-3950</td>
<td>02 - Paving, Silework; 03 - Concrete Placement</td>
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<td><a href="mailto:nicoletti@biosourceindustries.com">nicoletti@biosourceindustries.com</a></td>
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<td>7152 N AAA HWY</td>
<td>Fostoria</td>
<td>OH</td>
<td>41043</td>
<td>506-747-0222</td>
<td>506-747-0224</td>
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<td><a href="mailto:office@bison-services.com">office@bison-services.com</a></td>
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<td>Blackswamp Steel</td>
<td>300 E. Business Way, Suite 200</td>
<td>Cincinnati</td>
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<td>45421</td>
<td>513-277-4964</td>
<td>513-277-4996</td>
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<td>c洗礼<a href="mailto:mer@blackswampsteel.com">mer@blackswampsteel.com</a></td>
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<tr>
<td>Blackswamp Steel Inc.</td>
<td>1761 Commerce Pk</td>
<td>Holland</td>
<td>OH</td>
<td>43528</td>
<td>419-867-8590</td>
<td>419-867-8593</td>
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<td>Bowser Motor</td>
<td>4518 Taylorville Road</td>
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<td>937-233-2016</td>
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<td><a href="mailto:grg@bowser-motor.com">grg@bowser-motor.com</a></td>
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<td>Bradley Metal Fabrication, LLC</td>
<td>6211 Cedar Avenue</td>
<td>Cleveland</td>
<td>OH</td>
<td>44103</td>
<td>(216) 881-7400</td>
<td>(216) 881-7401</td>
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<td>Bridges Bros Trucking LLC</td>
<td>3809 Scuffield Dr</td>
<td>Gahanna</td>
<td>OH</td>
<td>44120</td>
<td>614-475-5003</td>
<td>614-306-7442</td>
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<td><a href="mailto:mbbridges3889@biglobal.net">mbbridges3889@biglobal.net</a></td>
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<td>Brightguy Inc.</td>
<td>38205 Stevens Blvd., Unit B</td>
<td>Willoughby</td>
<td>OH</td>
<td>44094</td>
<td>440-942-8318</td>
<td>440-942-2056</td>
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<td>17228 Mapleford Avenue</td>
<td>Maple Heights</td>
<td>OH</td>
<td>44137</td>
<td>216-624-8355</td>
<td>216-342-8493</td>
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<td>3330 East Waterloo Road</td>
<td>Akron</td>
<td>OH</td>
<td>44312</td>
<td>330-673-3889</td>
<td>330-673-9700</td>
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<td><a href="mailto:mealer@buckeye.com">mealer@buckeye.com</a></td>
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<td>Buckeye Ready-Mix, LLC</td>
<td>7657 Taylor Road</td>
<td>Reynoldsburg</td>
<td>OH</td>
<td>43058</td>
<td>740-369-4810</td>
<td>704-360-2131</td>
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<td>SBE</td>
<td><a href="mailto:info@buckyreadymix.com">info@buckyreadymix.com</a></td>
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<td>Buckeye Sealants &amp; Waterproofing</td>
<td>79 Fairground Rd.</td>
<td>Xenia</td>
<td>OH</td>
<td>45385</td>
<td>937-372-7386</td>
<td>937-372-7254</td>
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<td>Buckner &amp; Sons Masonry Inc.</td>
<td>3800 Sylvan Ave</td>
<td>Columbus</td>
<td>OH</td>
<td>43228</td>
<td>614-279-9777</td>
<td>614-279-7855</td>
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<td>44134</td>
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<td>C.A. Threats &amp; Sons, Inc.</td>
<td>1001 Kiely Court</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45217</td>
<td>513-542-0896</td>
<td>513-931-3309</td>
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<td>Cleveland</td>
<td>OH</td>
<td>44143</td>
<td>440-449-4005</td>
<td>440-449-0883</td>
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<td>Calvary Contracting</td>
<td>4125 Gibson Drive</td>
<td>Top City</td>
<td>OH</td>
<td>45371</td>
<td>907-754-0300</td>
<td>907-754-0400</td>
<td>05 - Millwork; 08 - Door Install; 09 - Acoustic</td>
<td>SDVOSB</td>
<td><a href="mailto:john.moss@calvarycontracting.com">john.moss@calvarycontracting.com</a></td>
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<td>Capital metal Industries</td>
<td>32400 Aurora Road, Suite 3</td>
<td>Solon</td>
<td>OH</td>
<td>44130</td>
<td>440-914-0700</td>
<td>440-914-0701</td>
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<td>Carr Bros. Inc.</td>
<td>7177 Northfield Road</td>
<td>Walton Hills</td>
<td>OH</td>
<td>44146</td>
<td>440-232-3700</td>
<td>440-786-7757</td>
<td>03 - Ready mix</td>
<td>WBE</td>
<td><a href="mailto:mike@carrbros.net">mike@carrbros.net</a></td>
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<td>CATTIS Construction, Inc.</td>
<td>7177 Northfield Road</td>
<td>Bedford</td>
<td>OH</td>
<td>44146</td>
<td>440-238-4394</td>
<td>889-657-6506</td>
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<td><a href="mailto:mshaker@calvarycontracting.com">mshaker@calvarycontracting.com</a></td>
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<td>Cleveland</td>
<td>OH</td>
<td>44105</td>
<td>216-460-6775</td>
<td>216-751-0346</td>
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<td>Cavotta Landscapers Inc.</td>
<td>19517 Nottingham Road</td>
<td>Cleveland</td>
<td>OH</td>
<td>44110</td>
<td>216-486-2505</td>
<td>216-486-2594</td>
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<td><a href="mailto:cfl@ahoglobal.net">cfl@ahoglobal.net</a></td>
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<td>Caco Concrete Construction</td>
<td>4550 Port Union Road</td>
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<td>513-874-0447</td>
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<td>Centaur Contracting, LLC</td>
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<td>216-701-2708</td>
<td>330-657-2651</td>
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<td>937-233-5910</td>
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<td><a href="mailto:huberewalt@cox.net">huberewalt@cox.net</a></td>
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<td>7850 Freeway Circle, Suite 110</td>
<td>Middletown</td>
<td>OH</td>
<td>44130</td>
<td>440-234-5000</td>
<td>440-234-1967</td>
<td>05 - Steel &amp; Metals, Steel Erection; 02 - Demolition</td>
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<td>3226 Valley Rd Ste. 300</td>
<td>Cleveland</td>
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<td>44109</td>
<td>216-485-6034</td>
<td>216-485-6036</td>
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<td>FBE CSB EDGE SBE</td>
<td><a href="mailto:amartin@cheltenhamtruck.com">amartin@cheltenhamtruck.com</a></td>
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<tr>
<td>Cincinnati Interiors, Ltd.</td>
<td>1150 Felt Lane</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45230</td>
<td>513-332-1547</td>
<td>513-332-6269</td>
<td>09 - Acoustic Ceiling</td>
<td>WBE</td>
<td><a href="mailto:cpl@cincinnatiinteriors.com">cpl@cincinnatiinteriors.com</a></td>
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<td>Circle City Relax, LLC</td>
<td>4002 Industrial Blvd</td>
<td>Indianapolis</td>
<td>IN</td>
<td>46254</td>
<td>317-917-8566</td>
<td>317-917-8729</td>
<td>03 - Reinforcing Steel Supply</td>
<td>MBE</td>
<td><a href="mailto:allie@cindycircle.com">allie@cindycircle.com</a></td>
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<td>CJ Industrial Supply, Inc.</td>
<td>15320 Waterloo Road</td>
<td>Cleveland</td>
<td>OH</td>
<td>44110</td>
<td>216-481-4448</td>
<td>216-481-24444</td>
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<td><a href="mailto:cindustrial@ohiodotnet.net">cindustrial@ohiodotnet.net</a></td>
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<td>Claypoole and Company Hauling Services, LLC</td>
<td>419 Township Avenue</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45216</td>
<td>513-641-5313</td>
<td>513-641-0197</td>
<td>02 - Trucking</td>
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<td><a href="mailto:huberewalt@cox.net">huberewalt@cox.net</a></td>
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<td>Cody Builders Supply</td>
<td>12002 North Lamar Blvd</td>
<td>Austin</td>
<td>TX</td>
<td>78753</td>
<td>512-339-9634</td>
<td>512-330-0155</td>
<td>05 - Steel &amp; Metals</td>
<td>WBE DBE</td>
<td><a href="mailto:metals@codybuildersupply.com">metals@codybuildersupply.com</a></td>
</tr>
<tr>
<td>Colby Woodworking Inc.</td>
<td>PO Box 138</td>
<td>Dayton</td>
<td>OH</td>
<td>45404</td>
<td>937-254-7647</td>
<td>937-224-7647</td>
<td>06 - Casework, Millwork</td>
<td>DLIS SBE</td>
<td><a href="mailto:colby@coastal.net">colby@coastal.net</a></td>
</tr>
<tr>
<td>Coleman Development Inc.</td>
<td>3580 E. 93rd St.</td>
<td>Cleveland</td>
<td>OH</td>
<td>44105</td>
<td>216-441-7615</td>
<td>216-441-7618</td>
<td>02 - Demolition, Remediation</td>
<td>MBE DBE EDGE</td>
<td><a href="mailto:cfoxleman@yahoo.com">cfoxleman@yahoo.com</a></td>
</tr>
<tr>
<td>Coleman Spohn Corp</td>
<td>1775 E 45th Street</td>
<td>Cleveland</td>
<td>OH</td>
<td>44103</td>
<td>216-431-6070</td>
<td>216-431-6284</td>
<td>15 - HVAC &amp; Plumbing</td>
<td>MBE</td>
<td><a href="mailto:mgagnon@colemanspohn.com">mgagnon@colemanspohn.com</a></td>
</tr>
<tr>
<td>Columbus Steel Erectors, Inc.</td>
<td>PO Box 26038</td>
<td>Columbus</td>
<td>OH</td>
<td>43228</td>
<td>614-876-5590</td>
<td>614-876-7950</td>
<td>05 - Steel Erection</td>
<td>SBE</td>
<td><a href="mailto:info@columbussteelerecors.com">info@columbussteelerecors.com</a></td>
</tr>
<tr>
<td>Columbus Interior Specialties Incorporated</td>
<td>475 W. Funderburg Road</td>
<td>Fairborn</td>
<td>OH</td>
<td>45324</td>
<td>937-879-2047</td>
<td>937-879-0003</td>
<td>09 - Acoustic Ceiling, Drywall, 07 - Insulation</td>
<td>WBE DBE</td>
<td><a href="mailto:ljwerner@comBuildinterior.com">ljwerner@comBuildinterior.com</a></td>
</tr>
<tr>
<td>Construction Solutions of</td>
<td>3404 Hardwood Forest Drive</td>
<td>Louisville</td>
<td>KY</td>
<td>40214</td>
<td>502-935-1764</td>
<td>502-935-1088</td>
<td>02 - Sitework</td>
<td>WBE</td>
<td><a href="mailto:CSK3762758@aol.com">CSK3762758@aol.com</a></td>
</tr>
<tr>
<td>Company</td>
<td>Address</td>
<td>City</td>
<td>State</td>
<td>Zip</td>
<td>Phone</td>
<td>Fax</td>
<td>Nature of Business</td>
<td>Diversity</td>
<td>Email</td>
</tr>
<tr>
<td>-----------------------------</td>
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<tr>
<td>Construction Support Solutions</td>
<td>PO Box 48</td>
<td>Acron Lake</td>
<td>OH</td>
<td>44012</td>
<td>440-541-6642</td>
<td>440-655-9482</td>
<td>01 - Scheduling Consultant</td>
<td>EDGE</td>
<td><a href="mailto:service@constructionsolutions.com">service@constructionsolutions.com</a></td>
</tr>
<tr>
<td>Contemporary Cabinetry East</td>
<td>8950 Roseash Rd</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45236</td>
<td>513-791-9115</td>
<td>513-791-8438</td>
<td>05 - Millwork</td>
<td>WBE</td>
<td><a href="mailto:estimating.cce@blue.net">estimating.cce@blue.net</a></td>
</tr>
<tr>
<td>Contracting &amp; Supply, LLC</td>
<td>P.O. Box 78115</td>
<td>Indianapolis</td>
<td>IN</td>
<td>46268</td>
<td>317-295-8151</td>
<td>317-295-1933</td>
<td>06 - FRP</td>
<td>WBE</td>
<td><a href="mailto:sales@contractingandsupply.com">sales@contractingandsupply.com</a></td>
</tr>
<tr>
<td>Cook Paving &amp; Construction Company, Inc.</td>
<td>11360 Brookpark Rd</td>
<td>Brooklyn</td>
<td>OH</td>
<td>44130</td>
<td>216-267-7705</td>
<td>216-267-7935</td>
<td>02 - Paving, Sitework</td>
<td>MBE, SBE, EDGE</td>
<td><a href="mailto:james.alex@cookpaving.com">james.alex@cookpaving.com</a></td>
</tr>
<tr>
<td>Coon Restoration &amp; Sealants Inc</td>
<td>7349 Ravenna Avenue NE P.O. Box Louisville</td>
<td>Avon Lake</td>
<td>OH</td>
<td>44041</td>
<td>330-875-2100</td>
<td>330-875-1721</td>
<td>07 - Waterproofing and Joint Sealants</td>
<td>SBE</td>
<td><a href="mailto:jreinbrink@coonrestoration.com">jreinbrink@coonrestoration.com</a></td>
</tr>
<tr>
<td>Cordova Enterprises LLC</td>
<td>3100 West 45th Street</td>
<td>Cleveland</td>
<td>OH</td>
<td>44127</td>
<td>216-441-9860</td>
<td>216-441-9865</td>
<td>02 - Trucking</td>
<td>MBE, WBE, SBE</td>
<td><a href="mailto:cordonelh@pwi.com">cordonelh@pwi.com</a></td>
</tr>
<tr>
<td>Corey J. Love Photography</td>
<td>32857 South Roundhead</td>
<td>Solon</td>
<td>OH</td>
<td>4139</td>
<td>440-941-5290</td>
<td></td>
<td>01 - Photography</td>
<td>SBE</td>
<td><a href="mailto:coreyjlove@gmail.com">coreyjlove@gmail.com</a></td>
</tr>
<tr>
<td>Cosmos Industrial Services Inc.</td>
<td>9120 Detroit Avenue</td>
<td>Cleveland</td>
<td>OH</td>
<td>44122</td>
<td>216-861-8361</td>
<td>216-861-4032</td>
<td>01 - Painting</td>
<td>FRE, NEORSD, WBE, EDGE</td>
<td>DBE</td>
</tr>
<tr>
<td>Countryside Gardens Inc.</td>
<td>3272 St Rt. 502</td>
<td>Greenville</td>
<td>OH</td>
<td>45331</td>
<td>937-623-1999</td>
<td></td>
<td>02 - Landscaping</td>
<td>EDGE</td>
<td><a href="mailto:bchim@yad.com">bchim@yad.com</a></td>
</tr>
<tr>
<td>Coopie Creative Imagery</td>
<td>9312 Aetna Road, Suite 2</td>
<td>Cleveland</td>
<td>OH</td>
<td>44129</td>
<td>216-271-0854</td>
<td></td>
<td>01 - Photography</td>
<td>SBE</td>
<td><a href="mailto:thecoopie@madburner.com">thecoopie@madburner.com</a></td>
</tr>
<tr>
<td>Craftsman Electric</td>
<td>3855 Alta Ave</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45236</td>
<td>513-891-4426</td>
<td>513-891-5434</td>
<td>16 - Electrical</td>
<td>DBE, UCP, WBE</td>
<td><a href="mailto:info@craftsmanelectric.com">info@craftsmanelectric.com</a></td>
</tr>
<tr>
<td>Cricket Mowing Inc.</td>
<td>1270 West 130th, Suite 304</td>
<td>Brunswick</td>
<td>OH</td>
<td>44212</td>
<td>440-343-5282</td>
<td>440-336-4655</td>
<td>02 - Sitework</td>
<td>WBE SBE</td>
<td><a href="mailto:cricketmowing@gmail.com">cricketmowing@gmail.com</a></td>
</tr>
<tr>
<td>Cromwell Mechanical LLC</td>
<td>3405 Perkins Avenue</td>
<td>Cleveland</td>
<td>OH</td>
<td>44114</td>
<td>216-373-7378</td>
<td></td>
<td>15 - HVAC &amp; Plumbing, Fire Protection, Gas</td>
<td>WBE</td>
<td><a href="mailto:crpmechanical@me.com">crpmechanical@me.com</a></td>
</tr>
<tr>
<td>CTL Engineering, Inc</td>
<td>2105 Schappele Ln</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45140</td>
<td>513-722-8665</td>
<td>513-834-6650</td>
<td>01 - Testing and Inspection</td>
<td>MBE, EDGE</td>
<td><a href="mailto:sbloew@ctle.com">sbloew@ctle.com</a></td>
</tr>
<tr>
<td>CTL Engineering, Inc</td>
<td>3085 Interstate Parkway</td>
<td>Brunswick</td>
<td>OH</td>
<td>44212</td>
<td>330-220-8944</td>
<td>330-220-6944</td>
<td>01 - Testing and Inspection</td>
<td>MBE</td>
<td><a href="mailto:chloe@ctle.com">chloe@ctle.com</a></td>
</tr>
<tr>
<td>CTL Engineering, Inc</td>
<td>2860 Fisher Rd.</td>
<td>Columbus</td>
<td>OH</td>
<td>43024</td>
<td>614-276-8123</td>
<td>614-276-6377</td>
<td>01 - Testing and Inspection</td>
<td>MBE</td>
<td><a href="mailto:chloe@ctle.com">chloe@ctle.com</a></td>
</tr>
<tr>
<td>CTL Engineering, Inc</td>
<td>102 Commerce Dr., PO Box 44</td>
<td>Wapakoneta</td>
<td>OH</td>
<td>45855</td>
<td>419-738-1447</td>
<td>419-738-7670</td>
<td>01 - Testing and Inspection</td>
<td>MBE</td>
<td><a href="mailto:tbl@wal-mart.com">tbl@wal-mart.com</a></td>
</tr>
<tr>
<td>Cunningham Paving</td>
<td>20814 Aurora Road</td>
<td>Warrensville Heights</td>
<td>OH</td>
<td>44146</td>
<td>216-581-8600</td>
<td>216-581-6883</td>
<td>02 - Paving, Sitework</td>
<td>SBE</td>
<td><a href="mailto:cunninghampaving@att.net">cunninghampaving@att.net</a></td>
</tr>
<tr>
<td>Custom Repairs &amp; Excavating LLC</td>
<td>412 Hettle Rd</td>
<td>Willard</td>
<td>OH</td>
<td>44890</td>
<td>419-465-4011</td>
<td>419-465-4011</td>
<td>02 - Aggregates, Trucking, Concrete Mix</td>
<td>MBE</td>
<td><a href="mailto:dwiggen@hrbcnet.com">dwiggen@hrbcnet.com</a></td>
</tr>
<tr>
<td>Cupahoga Fence</td>
<td>PO Box 43047</td>
<td>Cleveland</td>
<td>OH</td>
<td>44143</td>
<td>216-830-2200</td>
<td>216-830-2255</td>
<td>02 - Fence</td>
<td>DBE, EDGE, CSB, FRE, WBE, SBE</td>
<td><a href="mailto:gnnl@cupahogafence.com">gnnl@cupahogafence.com</a></td>
</tr>
<tr>
<td>Cupahoga Supply &amp; Tool, Inc.</td>
<td>5340 Perkine Rd</td>
<td>Bedford Hts</td>
<td>OH</td>
<td>44146</td>
<td>440-439-9393</td>
<td>440-439-6723</td>
<td>03 - Concrete Accessories</td>
<td>WBE, SBE</td>
<td><a href="mailto:dhurner@cupahogad.com">dhurner@cupahogad.com</a></td>
</tr>
<tr>
<td>CWS (Cincinnati Window Shade) Contract</td>
<td>3024 Hart Avenue</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45212</td>
<td>513-631-7200</td>
<td>513-631-8882</td>
<td>12 - Blinds, 10 - Cubicle Curtains &amp; Tracks</td>
<td>WBE</td>
<td><a href="mailto:cwp@wincorporated.com">cwp@wincorporated.com</a></td>
</tr>
<tr>
<td>D.A.G. Construction Company, Inc.</td>
<td>4624 Winton Rd</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45232</td>
<td>513-542-6597</td>
<td>513-542-5286</td>
<td>01 - GC, 03 - Concrete Placement; 08 - Doors</td>
<td>EDGE, MBE, DBE, UCP</td>
<td><a href="mailto:chad@dag.com">chad@dag.com</a></td>
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<tr>
<td>Dalton Protection</td>
<td>706 W. Xena Dr.</td>
<td>Fairborn</td>
<td>OH</td>
<td>45324</td>
<td>937-318-8053</td>
<td>937-318-0506</td>
<td>07 - Firestopping</td>
<td>WBE</td>
<td><a href="mailto:info@daltonprotection.com">info@daltonprotection.com</a></td>
</tr>
<tr>
<td>Darling Fire &amp; Safety Co.</td>
<td>13404 St. Clair</td>
<td>Cleveland</td>
<td>OH</td>
<td>44110</td>
<td>216-541-2224</td>
<td>216-541-4032</td>
<td>10 - Fire Extinguishers</td>
<td>WBE SBE</td>
<td><a href="mailto:dfco@shgglobal.com">dfco@shgglobal.com</a></td>
</tr>
<tr>
<td>Davis Marble and Tile Company</td>
<td>11310 Kenshire Drive</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45240</td>
<td>513-652-0696</td>
<td>513-851-9519</td>
<td>02 - Flooring</td>
<td>SBA, SBE, MBE</td>
<td><a href="mailto:daviemarbletile@yahoo.com">daviemarbletile@yahoo.com</a></td>
</tr>
<tr>
<td>Company</td>
<td>Address</td>
<td>City</td>
<td>State</td>
<td>Zip</td>
<td>Phone</td>
<td>Fax</td>
<td>Nature of Business</td>
<td>Diversity</td>
<td>Email</td>
</tr>
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<td>-------------------------------</td>
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<tr>
<td>DE Williams Electric Inc.</td>
<td>168 Solon Road, Suite B</td>
<td>Chagrin Falls</td>
<td>OH</td>
<td>44021</td>
<td>440-855-9591</td>
<td>440-855-9598</td>
<td>16 - Electrical</td>
<td>MBE</td>
<td><a href="mailto:jvyas@dewilliamselectric.com">jvyas@dewilliamselectric.com</a></td>
</tr>
<tr>
<td>Deere/Short Excavating</td>
<td>14830 Flatt Road</td>
<td>Marysville</td>
<td>OH</td>
<td>43040</td>
<td>330-644-0007</td>
<td>330-644-0181</td>
<td>02 - Sitework</td>
<td>MBE WBE</td>
<td><a href="mailto:shortexc@hotmail.com">shortexc@hotmail.com</a></td>
</tr>
<tr>
<td>Dependable Painting</td>
<td>4402 Superior Avenue</td>
<td>Cleveland</td>
<td>OH</td>
<td>44103</td>
<td>216-431-4770</td>
<td>216-431-6670</td>
<td>09 - Painting</td>
<td>WBE CSB SBE</td>
<td><a href="mailto:company@dependablepbg.com">company@dependablepbg.com</a></td>
</tr>
<tr>
<td>Devcomm Inc.</td>
<td>141 Sunset Road</td>
<td>Avon Lake</td>
<td>OH</td>
<td>44012</td>
<td>216-392-2118</td>
<td></td>
<td>01 - Software</td>
<td>MBE SBE</td>
<td><a href="mailto:devadoss@davcominc.com">devadoss@davcominc.com</a></td>
</tr>
<tr>
<td>Dmytryka Jacobs Engineers, Inc.</td>
<td>1101 Research Drive</td>
<td>Toledo</td>
<td>OH</td>
<td>43614</td>
<td>419-390-4900</td>
<td>419-390-4907</td>
<td>13 - Instrumentation &amp; Controls</td>
<td>MBE DBE</td>
<td><a href="mailto:dje@djeinc.com">dje@djeinc.com</a>; <a href="mailto:mbeeman@djeinc.com">mbeeman@djeinc.com</a></td>
</tr>
<tr>
<td>Domino Decorating of Ohio LLC</td>
<td>8442 West 130th Street</td>
<td>Strongsville</td>
<td>OH</td>
<td>44136</td>
<td>216-226-8810</td>
<td>440-582-2182</td>
<td>09 - Finishes</td>
<td>WBE SBE</td>
<td><a href="mailto:dominodeco@aol.com">dominodeco@aol.com</a></td>
</tr>
<tr>
<td>Donato Electric Inc.</td>
<td>4315 Payne Avenue</td>
<td>Cleveland</td>
<td>OH</td>
<td>44103</td>
<td>440-221-3029</td>
<td>440-357-8545</td>
<td>16 - Electrical</td>
<td>WBE SBE</td>
<td><a href="mailto:donatoelectric@att.net">donatoelectric@att.net</a></td>
</tr>
<tr>
<td>Done Right Commercial Cleaning</td>
<td>31 Birchwood Ave</td>
<td>Dayton</td>
<td>OH</td>
<td>45425</td>
<td>937-554-4374</td>
<td>937-938-5689</td>
<td>01 - Construction Clean Up</td>
<td>MBE SBE, DLBB</td>
<td><a href="mailto:kelvin.belcher1@atl.com">kelvin.belcher1@atl.com</a></td>
</tr>
<tr>
<td>DSEA Services, Inc.</td>
<td>506 Northland Blvd.</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45240</td>
<td>513-674-2231</td>
<td>513-674-2230</td>
<td>02 - Demolition, Remediation</td>
<td>WBE</td>
<td><a href="mailto:stabby@frontcity.or.com">stabby@frontcity.or.com</a></td>
</tr>
<tr>
<td>DDS Sweeping Service</td>
<td>1520 Nicholas road</td>
<td>Dayton</td>
<td>OH</td>
<td>45417</td>
<td>937-262-0123</td>
<td>937-262-0233</td>
<td>01 - Construction Clean Up</td>
<td>DBE WBE EDGE</td>
<td><a href="mailto:nancy@dds-sweeping.com">nancy@dds-sweeping.com</a></td>
</tr>
<tr>
<td>Dust Fabricators, Inc.</td>
<td>883 Addison Rd</td>
<td>Cleveland</td>
<td>OH</td>
<td>44103</td>
<td>216-391-2400</td>
<td>216-391-2492</td>
<td>15 - HVAC</td>
<td>CSB, FBE, LPE, SBE, WBE, NEORSD</td>
<td><a href="mailto:ompeguy@thebigone.com">ompeguy@thebigone.com</a></td>
</tr>
<tr>
<td>Dunlop Industries Inc.</td>
<td>12345 Valley Vista Drive</td>
<td>Chesterland</td>
<td>OH</td>
<td>44026</td>
<td>440-729-7543</td>
<td></td>
<td>15 - Pipes &amp; Valves</td>
<td>WBE SBE</td>
<td><a href="mailto:dunlop@neohusucker.com">dunlop@neohusucker.com</a></td>
</tr>
<tr>
<td>Dunnington General Maintenance, Inc.</td>
<td>7618 Brans Hill Drive</td>
<td>Centerville</td>
<td>OH</td>
<td>45450</td>
<td>937-439-3639</td>
<td>937-438-0756</td>
<td>01 - Construction Clean Up</td>
<td>WBE</td>
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</tr>
<tr>
<td>Earl Building Products, Inc.</td>
<td>30 Building AVE</td>
<td>Mariannburg</td>
<td>OH</td>
<td>45434</td>
<td>937-761-3275</td>
<td>937-847-9002</td>
<td>05 - Steel &amp; Metals</td>
<td>WBE, EDGE, SBE, FBE, DLBB</td>
<td><a href="mailto:earlbldg@atl.net">earlbldg@atl.net</a></td>
</tr>
<tr>
<td>Eclipse Co.</td>
<td>11554 East Washington</td>
<td>Chagrin Falls</td>
<td>OH</td>
<td>44021</td>
<td>440-543-3493</td>
<td>440-543-3495</td>
<td>02 - Sitework, 03 - concrete, 07 - Firestopping</td>
<td>WBE, EDGE, DBE, CSB</td>
<td><a href="mailto:tom@eclipsecollc.com">tom@eclipsecollc.com</a></td>
</tr>
<tr>
<td>EM Painting LLC</td>
<td>7700 New York Avenue</td>
<td>Cleveland</td>
<td>OH</td>
<td>44105</td>
<td>216-406-0600</td>
<td>330-468-8649</td>
<td>09 - Painting</td>
<td>WBE SBE</td>
<td><a href="mailto:emwater21@aol.com">emwater21@aol.com</a></td>
</tr>
<tr>
<td>Encore PreCast, LLC</td>
<td>416 West Ritter Street PO Box 380</td>
<td>Seven Mile</td>
<td>MI</td>
<td>48082</td>
<td>513-726-5678</td>
<td>513-726-5679</td>
<td>02 - Precast Structures/Site Pipe</td>
<td>SBE</td>
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</tr>
<tr>
<td>Energy 3000 LLC</td>
<td>3440 West 88th Street</td>
<td>Cleveland</td>
<td>OH</td>
<td>44102</td>
<td>565-348-7300</td>
<td></td>
<td>16 - Electrical</td>
<td>MBE SBE</td>
<td><a href="mailto:bkg@energy3000b.com">bkg@energy3000b.com</a></td>
</tr>
<tr>
<td>Enviro Recycling Group LLC</td>
<td>115 Bonham Ave</td>
<td>Columbus</td>
<td>OH</td>
<td>43211</td>
<td>614-670-8595</td>
<td>614-258-6614</td>
<td>02 - Demolition, Trucking</td>
<td>DBE MBE EDGE LEDE</td>
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<td>Erlanger Window Cleaning</td>
<td>3619 Old Fort Road Suite B</td>
<td>Erlanger</td>
<td>KY</td>
<td>41018</td>
<td>859-371-4210</td>
<td>859-371-5431</td>
<td>01 - Construction Clean Up</td>
<td>WBE</td>
<td><a href="mailto:dmunson@erlangernwindow.com">dmunson@erlangernwindow.com</a></td>
</tr>
<tr>
<td>Erosion Runner Midwest</td>
<td>390 Congress Park Drive</td>
<td>Dayton</td>
<td>OH</td>
<td>45459</td>
<td>513-435-5019</td>
<td></td>
<td>02 - Erosion Control</td>
<td>DBE EDGE</td>
<td><a href="mailto:ferb@errosionrunner.com">ferb@errosionrunner.com</a></td>
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<tr>
<td>Eyster Asbestos LLC</td>
<td>820 E. Monument Ave.</td>
<td>Dayton</td>
<td>OH</td>
<td>45402</td>
<td>513-226-7346</td>
<td></td>
<td>02 - Asbestos Abatement</td>
<td>SBE WBE</td>
<td><a href="mailto:eysterasbestos@gmail.com">eysterasbestos@gmail.com</a></td>
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<tr>
<td>Ezize Contractor</td>
<td>9927 Stonebridge Dr.</td>
<td>513-310-5793</td>
<td>OH</td>
<td>513-677-0171</td>
<td>02 - Trucking</td>
<td>WBE DBE SBE EDGE</td>
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<td><a href="mailto:ezizie@eziizie.com">ezizie@eziizie.com</a></td>
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<tr>
<td>Fabrication Group</td>
<td>3453 W. 140th Street</td>
<td>Cleveland</td>
<td>OH</td>
<td>44111</td>
<td>216-251-1125</td>
<td>216-251-1135</td>
<td>05 - Steel &amp; Metals</td>
<td>WBE</td>
<td><a href="mailto:sfadu@fabricationgroup.com">sfadu@fabricationgroup.com</a></td>
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<tr>
<td>Fabric Recycling</td>
<td>6751 Eastland Road</td>
<td>Middleburg Heights</td>
<td>OH</td>
<td>44130</td>
<td>216-239-7033</td>
<td>02 - Trucking</td>
<td>WBE SBE</td>
<td></td>
<td><a href="mailto:maria@fabrec-inc.com">maria@fabrec-inc.com</a></td>
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<tr>
<td>Falcon Materials</td>
<td>3636 Amberson Dr</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45208</td>
<td>513-383-4600</td>
<td>513-865-2039</td>
<td>02 - Aggregates</td>
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<tr>
<td>Fabrix Recycling</td>
<td>6751 Eastland Road</td>
<td>Middleburg Heights</td>
<td>OH</td>
<td>44130</td>
<td>216-239-7033</td>
<td>02 - Trucking</td>
<td>WBE SBE</td>
<td></td>
<td><a href="mailto:maria@fabrec-inc.com">maria@fabrec-inc.com</a></td>
</tr>
<tr>
<td>Company</td>
<td>Address</td>
<td>City</td>
<td>State</td>
<td>Zip</td>
<td>Phone</td>
<td>Fax</td>
<td>Nature of Business</td>
<td>Diversity</td>
<td>Email</td>
</tr>
<tr>
<td>------------------------------</td>
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</tr>
<tr>
<td>Federal Rent A Fence</td>
<td>PO Box 266</td>
<td>West Berlin</td>
<td>NJ</td>
<td>08091</td>
<td>800-260-8301</td>
<td>800-256-4783</td>
<td>02 - Fence</td>
<td>WBE</td>
<td><a href="mailto:burl@ran-n.com">burl@ran-n.com</a></td>
</tr>
<tr>
<td>First Star Safety, LLC</td>
<td>4 Kirvach Drive, Suite 430</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45215</td>
<td>513-651-7627</td>
<td>513-651-7629</td>
<td>02 - Site Security</td>
<td>SBEDBE</td>
<td>WBE HBE WBE WBE</td>
</tr>
<tr>
<td>Floorsikes Inc.</td>
<td>13477 Prospect Rd., Suite 211</td>
<td>Strongsville</td>
<td>OH</td>
<td>44140</td>
<td>440-268-3157</td>
<td>440-268-3158</td>
<td>09 - Flooring</td>
<td>SBE</td>
<td><a href="mailto:pete@fiprofloors.com">pete@fiprofloors.com</a></td>
</tr>
<tr>
<td>Foundation Steel, LLC</td>
<td>12545 Airport Hwy. Bldgs A &amp; B</td>
<td>Swanton</td>
<td>OH</td>
<td>43558</td>
<td>419-402-4241</td>
<td>419-402-4246</td>
<td>03 - Reinforcing Steel Install, 05 - Steel Erection</td>
<td>WBE</td>
<td><a href="mailto:info@foundationsteell.net">info@foundationsteell.net</a></td>
</tr>
<tr>
<td>Fox Contractors Corp.</td>
<td>5430 W. Ferguson Rd.</td>
<td>Fort Wayne</td>
<td>IN</td>
<td>46820</td>
<td>260-747-7461</td>
<td>260-747-7717</td>
<td>02 - SiteWork, Demolition</td>
<td>MBE</td>
<td><a href="mailto:bkoehn@foxcontractors.com">bkoehn@foxcontractors.com</a></td>
</tr>
<tr>
<td>Frank Olle Landscape and Design Group</td>
<td>PO Box 42547</td>
<td>Louisville</td>
<td>KY</td>
<td>40253</td>
<td>502-245-1571</td>
<td>502-245-9788</td>
<td>02 - Landscaping</td>
<td>FBE</td>
<td></td>
</tr>
<tr>
<td>Friedel Trucking Co., Inc.</td>
<td>5714 Archmere Avenue</td>
<td>Cincinnati</td>
<td>OH</td>
<td>44144</td>
<td>440-237-5277</td>
<td></td>
<td>02 - Trucking</td>
<td>WBE SBE</td>
<td><a href="mailto:m45774@yahoo.com">m45774@yahoo.com</a></td>
</tr>
<tr>
<td>G.C. Pace Painting</td>
<td>PO Box 40451</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45240</td>
<td>513-383-8361</td>
<td>614-358-8361</td>
<td>09 - Painting</td>
<td>MBEEDGE</td>
<td><a href="mailto:philip@gcpacepainting.com">philip@gcpacepainting.com</a></td>
</tr>
<tr>
<td>Gabor Enterprises Inc.</td>
<td>2885 Niagara Avenue, Suite 2</td>
<td>Perry</td>
<td>OH</td>
<td>44144</td>
<td>440-357-8804</td>
<td>440-357-8956</td>
<td>07 - Waterproofing and Joint Sealants; 04 - 1</td>
<td>WBE SBE</td>
<td><a href="mailto:Amy@gaborenterprises.com">Amy@gaborenterprises.com</a></td>
</tr>
<tr>
<td>Gaines Mechanical Contractors</td>
<td>528 Hal Avenue</td>
<td>Dayton</td>
<td>OH</td>
<td>45404</td>
<td>937-276-2206</td>
<td>937-276-3553</td>
<td>15 - HVAC</td>
<td>MBE</td>
<td><a href="mailto:sedge@ginennemechanical.com">sedge@ginennemechanical.com</a></td>
</tr>
<tr>
<td>Garcia Surveyors Inc.</td>
<td>6055 Providence St.</td>
<td>Whitehouse</td>
<td>OH</td>
<td>43571</td>
<td>419-877-0400</td>
<td>419-877-1140</td>
<td>01 - Surveying</td>
<td>DBE</td>
<td><a href="mailto:davdavinci@giacovasurveyors.com">davdavinci@giacovasurveyors.com</a></td>
</tr>
<tr>
<td>Gardner Tobin, Inc.</td>
<td>227 East Helena St., PO Box 121</td>
<td>Dayton</td>
<td>OH</td>
<td>45404</td>
<td>937-222-1522</td>
<td>937-222-0568</td>
<td>08 - Doors Frames &amp; Hardware; 10 - Special</td>
<td>EDGE</td>
<td><a href="mailto:cliedav@davertobin.com">cliedav@davertobin.com</a></td>
</tr>
<tr>
<td>GEG Painting, Inc.</td>
<td>8530 Westford Ave.</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45236</td>
<td>513-984-0109</td>
<td>513-984-1871</td>
<td>09 - Painting</td>
<td>WBE SBE</td>
<td><a href="mailto:GEGpainting@cinci.rr.com">GEGpainting@cinci.rr.com</a></td>
</tr>
<tr>
<td>Geiger Construction Products, Inc.</td>
<td>850 North Bend Road PO Box 24-J</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45224</td>
<td>513-242-5106</td>
<td>513-242-7933</td>
<td>07 - Metal Wall Panels; 08 - Aluminum Store</td>
<td>SBE</td>
<td><a href="mailto:rchmig@geigerproducts.com">rchmig@geigerproducts.com</a></td>
</tr>
<tr>
<td>Georgia Direct Carpet Inc.</td>
<td>1530 South 39th Street</td>
<td>Richmond</td>
<td>IN</td>
<td>460-878-3133</td>
<td>317-219-6035</td>
<td>09 - Flooring</td>
<td>MBE</td>
<td><a href="mailto:trudy@georgiadirdirect.com">trudy@georgiadirdirect.com</a></td>
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</tr>
<tr>
<td>Gastech Services, Inc.</td>
<td>350 Golden Oak Parkway</td>
<td>Cleveland</td>
<td>OH</td>
<td>44146</td>
<td>440-439-5821</td>
<td>440-439-1544</td>
<td>02 - Deep Foundations, Shoring, Grouting</td>
<td>SBE</td>
<td><a href="mailto:gage@gastechs.com">gage@gastechs.com</a></td>
</tr>
<tr>
<td>Giner Electrical Contractors LLC</td>
<td>3930 Coleman Avenue</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45223</td>
<td>513-821-9302</td>
<td>513-821-9329</td>
<td>16 - Electrical</td>
<td>SBE</td>
<td><a href="mailto:gainer@ginerelectric.com">gainer@ginerelectric.com</a></td>
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<tr>
<td>GMA Computer Rooms Services dba Plenum Control</td>
<td>6779 Memphis Ave., Suite B</td>
<td>Cleveland</td>
<td>OH</td>
<td>44144</td>
<td>216-201-0035</td>
<td>216-258-0004</td>
<td>07 - Firestopping</td>
<td>MBE</td>
<td><a href="mailto:info@plenumcontrol.com">info@plenumcontrol.com</a></td>
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<tr>
<td>Goode Masonry</td>
<td>800 Mapleside Drive</td>
<td>Trotwood</td>
<td>OH</td>
<td>45426</td>
<td>517-718-3612</td>
<td>517-529-4297</td>
<td>04 - Masonry Sub</td>
<td>MBE SBE</td>
<td><a href="mailto:allen.gordon2009@yahoo.com">allen.gordon2009@yahoo.com</a></td>
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<tr>
<td>Grand River Electric LLC</td>
<td>1030 Bank St Street #B</td>
<td>Painesville</td>
<td>OH</td>
<td>44627</td>
<td>440-254-3602</td>
<td>440-760-4001</td>
<td>16 - Electrical</td>
<td>MBE SBE</td>
<td><a href="mailto:grandriverelectric01@gmail.com">grandriverelectric01@gmail.com</a></td>
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<tr>
<td>Granville Builders Supply</td>
<td>130 N Cedar Street</td>
<td>Newark</td>
<td>OH</td>
<td>43055</td>
<td>740-349-9691</td>
<td>740-349-8582</td>
<td>03 - Ready Mix</td>
<td>EDGE</td>
<td>WBE HBE WBE WBE</td>
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<td>Great Lakes Steel LLC</td>
<td>200 Fox Hollow Drive, Suite 204</td>
<td>Cleveland</td>
<td>OH</td>
<td>44124</td>
<td>440-681-2002</td>
<td>440-653-4913</td>
<td>05 - Steel &amp; Metals</td>
<td>SBE</td>
<td><a href="mailto:rank@glsteell.net">rank@glsteell.net</a></td>
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<tr>
<td>Gutho Schrick LLC</td>
<td>1113 Rockside Rd Unit 5 Ste. 9</td>
<td>Parma</td>
<td>OH</td>
<td>44134</td>
<td>216-642-7530</td>
<td>216-603-2444</td>
<td>02 - Deep Foundations, Shoring, Grouting</td>
<td>MBE SBE</td>
<td><a href="mailto:troydick@amerginsure.com">troydick@amerginsure.com</a></td>
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<tr>
<td>Hammond Corp.</td>
<td>1285 East 49th Street</td>
<td>Cleveland</td>
<td>OH</td>
<td>44141</td>
<td>216-431-7961</td>
<td>216-431-7964</td>
<td>15 - HVAC &amp; Plumbing</td>
<td>MBE SBE</td>
<td><a href="mailto:hammondco@sted.com">hammondco@sted.com</a></td>
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<tr>
<td>Heavy Equipment Rental</td>
<td>12514 Reynolds Dr. #B</td>
<td>Fishers</td>
<td>IN</td>
<td>46028</td>
<td>317-845-1518</td>
<td>317-845-1011</td>
<td>01 - Equipment Rental</td>
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<tr>
<td>Herbal Electric Company</td>
<td>1384 E. 26th St</td>
<td>Cleveland</td>
<td>OH</td>
<td>44114</td>
<td>216-621-5890</td>
<td>216-621-5893</td>
<td>16 - Electrical</td>
<td>SBE</td>
<td><a href="mailto:sari@herbelectronic.com">sari@herbelectronic.com</a></td>
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<tr>
<td>Company</td>
<td>Address</td>
<td>City</td>
<td>State</td>
<td>Zip</td>
<td>Phone 1</td>
<td>Phone 2</td>
<td>Nature of Business</td>
<td>Diversity</td>
<td>Email</td>
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<tr>
<td>HEZ Enterprise LLC</td>
<td>11212 Avon Avenue</td>
<td>Cleveland</td>
<td>OH</td>
<td>44105</td>
<td>216-644-9433</td>
<td>216-751-8056</td>
<td>02 - Sitework</td>
<td>MBE SBE</td>
<td><a href="mailto:redogen30@hotmail.com">redogen30@hotmail.com</a></td>
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<tr>
<td>Hina Environmental Solutions, LLC</td>
<td>3282-B Fisher Rd.</td>
<td>Columbus</td>
<td>OH</td>
<td>43204</td>
<td>614-272-7980</td>
<td>614-272-8787</td>
<td>02 - Demolition, Remediation</td>
<td>WBE HUB EDGE</td>
<td><a href="mailto:bhina@hinaenvironmental.com">bhina@hinaenvironmental.com</a></td>
</tr>
<tr>
<td>HMR Restoration Ltd.</td>
<td>4406 St. Clair Avenue</td>
<td>Cleveland</td>
<td>OH</td>
<td>44103</td>
<td>216-881-4142</td>
<td>216-881-6557</td>
<td>07 - Waterproofing and Joint Sealants; 04 - 1</td>
<td>WBE SBE</td>
<td><a href="mailto:hmmrestor@aol.com">hmmrestor@aol.com</a></td>
</tr>
<tr>
<td>Hoover &amp; Wells Inc. (Hoover Wells)</td>
<td>2011 Seaman Road</td>
<td>Toledo</td>
<td>OH</td>
<td>43005</td>
<td>419-631-9200</td>
<td>419-631-2818</td>
<td>09 - Epoxy/Flooring</td>
<td>WBE</td>
<td><a href="mailto:mark@hooverwells.com">mark@hooverwells.com</a></td>
</tr>
<tr>
<td>HTA Enterprises Inc</td>
<td>PO Box 72035</td>
<td>Louisville</td>
<td>KY</td>
<td>40272</td>
<td>502-933-5000</td>
<td>502-933-0501</td>
<td>02 - Sitework, Drilling &amp; Blasting</td>
<td>MBE</td>
<td><a href="mailto:harold.cahalin@htaenterprises.com">harold.cahalin@htaenterprises.com</a></td>
</tr>
<tr>
<td>Hurt's Trucking, LLC</td>
<td>13111 State Route 347</td>
<td>Mason</td>
<td>OH</td>
<td>43040</td>
<td>614-206-6807</td>
<td>937-642-7223</td>
<td>02 - Trucking</td>
<td>EDGE</td>
<td><a href="mailto:mark@hurtstrucking.com">mark@hurtstrucking.com</a></td>
</tr>
<tr>
<td>IC Roofing</td>
<td>762 Reading Road, Suite G</td>
<td>Mason</td>
<td>OH</td>
<td>45404</td>
<td>513-372-5203</td>
<td>513-672-2881</td>
<td>07 - Roofing and Steel Metal</td>
<td>MBE EDGE</td>
<td><a href="mailto:bhinaenvironmental@aol.com">bhinaenvironmental@aol.com</a></td>
</tr>
<tr>
<td>ICS Electrical Services, Inc.</td>
<td>7024 Harrison Avenue Suite 3</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45247</td>
<td>513-662-2800</td>
<td>513-662-2011</td>
<td>13 - Instrumentation &amp; Controls; 16 - Electric</td>
<td>SBE</td>
<td><a href="mailto:gguenther@ICSelectricalservices.com">gguenther@ICSelectricalservices.com</a></td>
</tr>
<tr>
<td>Imperial Mechanical</td>
<td>30685 Solon Industrial Parkway</td>
<td>Solon</td>
<td>OH</td>
<td>44139</td>
<td>440-488-1788</td>
<td>440-486-1388</td>
<td>15 - HVAC</td>
<td>WBE SBE</td>
<td><a href="mailto:bim@imperialHVAC.com">bim@imperialHVAC.com</a></td>
</tr>
<tr>
<td>Industrial Surface Sealer Inc.</td>
<td>4000 East 86th Street</td>
<td>Cleveland</td>
<td>OH</td>
<td>44105</td>
<td>216-341-2862</td>
<td>216-341-1216</td>
<td>02 - Paving</td>
<td>SBE</td>
<td><a href="mailto:dhans@industrialsurface.com">dhans@industrialsurface.com</a></td>
</tr>
<tr>
<td>Inside Outfitters Inc.</td>
<td>5725 Avery Road</td>
<td>Dublin</td>
<td>OH</td>
<td>43016</td>
<td>614-798-3500</td>
<td>614-798-3511</td>
<td>12 - Blinds; 10 - Cubicle Curtains &amp; Tracks</td>
<td>WBE</td>
<td><a href="mailto:insideoutliersinc@outlook.com">insideoutliersinc@outlook.com</a></td>
</tr>
<tr>
<td>Ivy Development Agency</td>
<td>PO Box 60274</td>
<td>Toledo</td>
<td>OH</td>
<td>43068</td>
<td>419-467-0017</td>
<td>907-276-6676</td>
<td>03 - Reinforcing Steel Install</td>
<td>DIBE, MBE, EDGE</td>
<td><a href="mailto:erik@ihill.net">erik@ihill.net</a></td>
</tr>
<tr>
<td>J &amp; L Door Service</td>
<td>7998 Mayfield Road</td>
<td>Chesterland</td>
<td>OH</td>
<td>44026</td>
<td>440-729-4261</td>
<td>440-729-4282</td>
<td>08 - Overhead Doors</td>
<td>WBE SBE</td>
<td><a href="mailto:lwns@lswor.com">lwns@lswor.com</a></td>
</tr>
<tr>
<td>J Enterprises Construction, Inc.</td>
<td>PO Box 80274</td>
<td>Dayton</td>
<td>OH</td>
<td>43011</td>
<td>937-985-6605</td>
<td>877-690-1785</td>
<td>09 - Acoustical Ceiling, Drywall</td>
<td>MBE EDGE DLSB</td>
<td><a href="mailto:jhills@jenterprises-construction.com">jhills@jenterprises-construction.com</a></td>
</tr>
<tr>
<td>J&amp;B Steel Erectors</td>
<td>9420 Sulin Place</td>
<td>Hamilton</td>
<td>OH</td>
<td>45011</td>
<td>513-874-1722</td>
<td>513-870-4383</td>
<td>03 - Reinforcing Steel Install, 05 - Steel Enc</td>
<td>WBE SBE DIBE EDGE</td>
<td><a href="mailto:bgs@steel.com">bgs@steel.com</a></td>
</tr>
<tr>
<td>JA McMahon Inc.</td>
<td>649 Grant Street</td>
<td>Niles</td>
<td>OH</td>
<td>44446</td>
<td>330-652-2388</td>
<td>330-652-2431</td>
<td>05 - Steel &amp; Metals</td>
<td>DBE</td>
<td><a href="mailto:cmk29@comcast.com">cmk29@comcast.com</a></td>
</tr>
<tr>
<td>Jaco Waterproofing LLC</td>
<td>PO Box 805</td>
<td>Ross</td>
<td>OH</td>
<td>45061</td>
<td>513-738-0814</td>
<td>513-738-0697</td>
<td>07 - Waterproofing and Joint Sealants</td>
<td>MBE</td>
<td><a href="mailto:eric@jacowaterproofing.com">eric@jacowaterproofing.com</a></td>
</tr>
<tr>
<td>Jadon Construction Services, Inc.</td>
<td>9901 York-thea Dr.</td>
<td>North Royalton</td>
<td>OH</td>
<td>44133</td>
<td>440-582-8534</td>
<td>440-582-8538</td>
<td>07 - Waterproofing and Joint Sealants; 03 - 1</td>
<td>WBE SBE</td>
<td><a href="mailto:mliepa@jadonconstructionservices.com">mliepa@jadonconstructionservices.com</a></td>
</tr>
<tr>
<td>JL Davis Electrical Contractors</td>
<td>PO Box 1008 235 Knox Street</td>
<td>Bourbonville</td>
<td>KY</td>
<td>40906</td>
<td>606-546-8461</td>
<td>606-546-8561</td>
<td>16 - Electrical</td>
<td>SDVOSB</td>
<td><a href="mailto:blec@hotmail.com">blec@hotmail.com</a></td>
</tr>
<tr>
<td>JMC Mechanical Inc.</td>
<td>9 Broadway St.</td>
<td>Wapakoneta</td>
<td>OH</td>
<td>45895</td>
<td>419-739-2400</td>
<td>419-739-2391</td>
<td>15 - HVAC &amp; Plumbing</td>
<td>EDGE</td>
<td><a href="mailto:estimation@jmcmechanical.com">estimation@jmcmechanical.com</a></td>
</tr>
<tr>
<td>JMD Transport, LLC</td>
<td>14900 York Road, Suite A</td>
<td>North Royalton</td>
<td>OH</td>
<td>44133</td>
<td>216-509-9834</td>
<td>216-991-1406</td>
<td>01 - Testing &amp; Inspection, 05 - Steel &amp; Metal</td>
<td>WBE SBE</td>
<td><a href="mailto:jmdtransportllc@gmail.com">jmdtransportllc@gmail.com</a></td>
</tr>
<tr>
<td>Jones Technologies Enterprises</td>
<td>13830 Union Avenue</td>
<td>Cleveland</td>
<td>OH</td>
<td>44120</td>
<td>216-551-2772</td>
<td>216-991-1406</td>
<td>01 - Testing &amp; Inspection, 05 - Steel &amp; Metal</td>
<td>MBE SBE</td>
<td><a href="mailto:jreid@jonescorporated.com">jreid@jonescorporated.com</a></td>
</tr>
<tr>
<td>Joslin Construction</td>
<td>2335 Florence Avenue</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45206</td>
<td>513-559-2990</td>
<td>513-559-1997</td>
<td>03 - Concrete Placement</td>
<td>MBE SBE EDGE</td>
<td><a href="mailto:jodinman@joslinconstruction.com">jodinman@joslinconstruction.com</a></td>
</tr>
<tr>
<td>JPC Plumbing Co. of Cleveland LLC</td>
<td>7815 Harvard Avenue</td>
<td>Cleveland</td>
<td>OH</td>
<td>44115</td>
<td>216-429-2575</td>
<td>216-883-6311</td>
<td>15 - Plumbing</td>
<td>WBE SBE</td>
<td><a href="mailto:gpittejohn45@gmail.com">gpittejohn45@gmail.com</a></td>
</tr>
<tr>
<td>Jubilee Excavation</td>
<td>16781 Chagrin #197</td>
<td>Shaker Heights</td>
<td>OH</td>
<td>44120</td>
<td>216-210-7527</td>
<td>216-245-3615</td>
<td>02 - Sitework</td>
<td>MBE SBE</td>
<td><a href="mailto:jubileewaco@gmail.com">jubileewaco@gmail.com</a></td>
</tr>
<tr>
<td>JVT&amp;G</td>
<td>3615 Superior Avenue E # 31</td>
<td>Cleveland</td>
<td>OH</td>
<td>44114</td>
<td>216-425-1580</td>
<td>216-426-1717</td>
<td>09 - Acoustical Ceiling, Drywall, EIFS, Finpro</td>
<td>MBE</td>
<td><a href="mailto:info@jvta-construction.com">info@jvta-construction.com</a></td>
</tr>
<tr>
<td>Company</td>
<td>Address</td>
<td>City</td>
<td>State</td>
<td>Zip</td>
<td>Phone</td>
<td>Fax</td>
<td>Nature of Business</td>
<td>Diversity</td>
<td>Email</td>
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<tr>
<td>K &amp; T Construction and Supply,</td>
<td>275 Conover Drive</td>
<td>Franklin</td>
<td>OH</td>
<td>45005</td>
<td>937-790-1020</td>
<td>937-790-1022</td>
<td>02 - Demolition, Stowage, 03 - Concrete, 05</td>
<td>EDGE MBE WBE HUBZone SBE</td>
<td><a href="mailto:richard@ktconstructioninc.com">richard@ktconstructioninc.com</a></td>
</tr>
<tr>
<td>Inc.</td>
<td></td>
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<tr>
<td>K. Davis, Inc.</td>
<td>605 W. Brentwood Dr.</td>
<td>Gilsenburg</td>
<td>OH</td>
<td>43431</td>
<td>419-307-0805</td>
<td></td>
<td>15 - Pipes &amp; Valves, 03 - Construction Supply</td>
<td>MBE WBE EDGE</td>
<td><a href="mailto:kevindavis66@yahoo.com">kevindavis66@yahoo.com</a></td>
</tr>
<tr>
<td>K-Cor LLC</td>
<td>11071 Main St.</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45241</td>
<td>513-769-8200</td>
<td>513-785-0024</td>
<td>03 - Reinforcing Steel Install &amp; Supply</td>
<td>MBE, EDGE, SBE</td>
<td><a href="mailto:grynder@kcor.net">grynder@kcor.net</a></td>
</tr>
<tr>
<td>Keane Fire &amp; Safety</td>
<td>1500 Main Street</td>
<td>Waltham</td>
<td>MA</td>
<td>02451</td>
<td>781-893-8505</td>
<td>781-893-2684</td>
<td>10 - Fire Extinguishers</td>
<td>WBE</td>
<td><a href="mailto:Janari@keanefire.com">Janari@keanefire.com</a></td>
</tr>
<tr>
<td>Keen Harris Trucking, LLC</td>
<td>1600 S. Yellow Springs Street</td>
<td>Springfield</td>
<td>OH</td>
<td>45506</td>
<td>937-323-8486</td>
<td>937-324-0035</td>
<td>02 - Trucking</td>
<td>DBE SDBE MBE</td>
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</tr>
<tr>
<td>Kin-Co (Car Brothers Concrete)</td>
<td>10800 Bryant Avenue</td>
<td>Cleveland</td>
<td>OH</td>
<td>44110</td>
<td>216-253-9152</td>
<td>440-766-7157</td>
<td>03 - Ready Mix</td>
<td>MBE SBE</td>
<td><a href="mailto:mkb@carbro.com">mkb@carbro.com</a></td>
</tr>
<tr>
<td>King Business Interiors Inc.</td>
<td>6155 Huntley Road Ste D</td>
<td>Columbus</td>
<td>OH</td>
<td>43229</td>
<td>614-430-0020</td>
<td>614-430-0022</td>
<td>09 - Floor, 12 - Furnishings</td>
<td>WBE EDGE</td>
<td><a href="mailto:gshuffelton@ktbinc.com">gshuffelton@ktbinc.com</a></td>
</tr>
<tr>
<td>King John Tiles</td>
<td>6797 N. High Street Ste. 304</td>
<td>Worthington</td>
<td>OH</td>
<td>43665</td>
<td>614-358-3418 x 7614-245-0020</td>
<td>02 - Trucking</td>
<td>MBE, DBE, EDGE</td>
<td><a href="mailto:michael@kingjohntoilets.com">michael@kingjohntoilets.com</a></td>
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</tr>
<tr>
<td>KLE Construction Co.</td>
<td>PO Box 373</td>
<td>Akron</td>
<td>OH</td>
<td>44314</td>
<td>330-745-2670</td>
<td>330-745-2672</td>
<td>03 - Reinforcing Steel Install</td>
<td>EDGE MBE DBIE</td>
<td><a href="mailto:trishard1953@live.com">trishard1953@live.com</a></td>
</tr>
<tr>
<td>Komest Plumbing, Heating &amp; Air</td>
<td>7870 W. Third St.</td>
<td>Dayton</td>
<td>OH</td>
<td>45417</td>
<td>937-854-2303</td>
<td>937-854-5033</td>
<td>15 - HVAC &amp; Plumbing</td>
<td>WBE SBE EDGE DSLB</td>
<td>estimating@laboratorydesignandequipme</td>
</tr>
<tr>
<td>Laboratory Design and Equipment</td>
<td>1569 Katy Lane</td>
<td>Fort Mill</td>
<td>SC</td>
<td>29706</td>
<td>803-548-0067</td>
<td>803-548-3043</td>
<td>12 - Lab Casework, 05 - Finish Carpentry</td>
<td>WBE</td>
<td></td>
</tr>
<tr>
<td>Le Famille</td>
<td>4407 Crosby Court</td>
<td>Louisville</td>
<td>KY</td>
<td>40218</td>
<td>502-473-1776</td>
<td>502-473-0043</td>
<td>03 - Reinforcing Steel Supply, Concrete Acco</td>
<td>MBE DBE SDVOSB</td>
<td><a href="mailto:lefamille@man.com">lefamille@man.com</a></td>
</tr>
<tr>
<td>Lead Minority-Vendor, Inc.</td>
<td>7175 Post Bridge Rd</td>
<td>Spring TX</td>
<td>TX</td>
<td>77380</td>
<td>281-357-4609</td>
<td></td>
<td>06 - FRP, 28 - Metals</td>
<td>MBE HUB</td>
<td><a href="mailto:wpdixon2006@bellsouthgl.net">wpdixon2006@bellsouthgl.net</a></td>
</tr>
<tr>
<td>LMR Construction Co. Inc.</td>
<td>13271 Bass Lake Road</td>
<td>Chardon</td>
<td>OH</td>
<td>44024</td>
<td>440-286-2093</td>
<td>440-286-2095</td>
<td>04 - Masonry Sub</td>
<td>EDGE, NEORSD, FBE</td>
<td><a href="mailto:Contact@LMR-Construction.com">Contact@LMR-Construction.com</a></td>
</tr>
<tr>
<td>Lkimos Reinforcing, Inc.</td>
<td>PO Box 21325</td>
<td>Louisville</td>
<td>KY</td>
<td>40221-0325</td>
<td>502-634-5030</td>
<td>502-634-4008</td>
<td>03 - Reinforcing Steel Install</td>
<td>WBE</td>
<td><a href="mailto:lkimosky@aol.com">lkimosky@aol.com</a></td>
</tr>
<tr>
<td>M &amp; M Manufacturing, Inc</td>
<td>709 Sportsman Lake Road</td>
<td>Franklin</td>
<td>KY</td>
<td>42134</td>
<td>270-586-8208</td>
<td>270-586-6424</td>
<td>05 - Steel &amp; metals</td>
<td>WBE(MSD,AWDC), DBIE</td>
<td><a href="mailto:mesiac@mm-manufacturing.com">mesiac@mm-manufacturing.com</a></td>
</tr>
<tr>
<td>MJS Flooring, Inc.</td>
<td>300 Shotwell Drive</td>
<td>Franklin</td>
<td>OH</td>
<td>45005</td>
<td>937-743-9900</td>
<td>937-743-9970</td>
<td>09 - Flooring</td>
<td>SBE EDGE</td>
<td><a href="mailto:scenesb@msfloor.com">scenesb@msfloor.com</a></td>
</tr>
<tr>
<td>M. Brooks Trucking LLC</td>
<td>1158 Bergenia Drive</td>
<td>Reynoldsburg</td>
<td>OH</td>
<td>43098</td>
<td>614-743-1020</td>
<td>614-626-0896</td>
<td>02 - Trucking</td>
<td>MBE</td>
<td><a href="mailto:mdbrookstrucking56@yahoo.com">mdbrookstrucking56@yahoo.com</a></td>
</tr>
<tr>
<td>Meck Industries Inc.</td>
<td>201 Columbus Road</td>
<td>Valley City</td>
<td>OH</td>
<td>44280</td>
<td>800-482-3111</td>
<td>300-482-2990</td>
<td>03 - Paving, 11 - Treatment Plant</td>
<td>WBE NEORSD</td>
<td><a href="mailto:dbell@mackconcrete.com">dbell@mackconcrete.com</a></td>
</tr>
<tr>
<td>Mad River Construction</td>
<td>4806 Shelter Avenue</td>
<td>Dayton</td>
<td>OH</td>
<td>45432</td>
<td>937-271-6075</td>
<td>937-253-5605</td>
<td>01 - GC, 02 - Fence, 09 - Acoustic Ceiling, C</td>
<td>EDGE SBE DSLB WBE</td>
<td><a href="mailto:info@madriverconstruction.com">info@madriverconstruction.com</a></td>
</tr>
<tr>
<td>Martin Paving &amp; Maintenance Co.,</td>
<td>10049 Applegate</td>
<td>Brighton</td>
<td>MI</td>
<td>48114</td>
<td>810-588-6880</td>
<td>810-222-0552</td>
<td>09 - Painting, Epoxy Floors</td>
<td>WBE</td>
<td><a href="mailto:gomartinpaving@gmail.com">gomartinpaving@gmail.com</a></td>
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<tr>
<td>Inc.</td>
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<td>MBE</td>
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<tr>
<td>Meyers Electric Company</td>
<td>4004 Erie Court</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45227</td>
<td>513-272-2900</td>
<td>513-272-2904</td>
<td>16 - Electrical</td>
<td>SBE</td>
<td><a href="mailto:foppe@meyerselectric.com">foppe@meyerselectric.com</a></td>
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<tr>
<td>Mechanical Systems of Dayton,</td>
<td>4401 Springfield St</td>
<td>Dayton</td>
<td>OH</td>
<td>45431</td>
<td>937-254-3225</td>
<td>937-254-4295</td>
<td>15 - HVAC &amp; Plumbing</td>
<td>WBE</td>
<td><a href="mailto:estimations@modicco.net">estimations@modicco.net</a></td>
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<tr>
<td>Inc.</td>
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<tr>
<td>MESSER and Associates</td>
<td>PO Box 21293</td>
<td>Louisville</td>
<td>KY</td>
<td>40221</td>
<td>502-515-2451</td>
<td>502-513-0040</td>
<td>02 - Trucking</td>
<td>MBE DBE SBE</td>
<td><a href="mailto:betmesser@messarence.com">betmesser@messarence.com</a></td>
</tr>
<tr>
<td>Miami Valley Masonry</td>
<td>2300 One Ave</td>
<td>Dayton</td>
<td>OH</td>
<td>45414</td>
<td>937-274-2179</td>
<td>937-274-9075</td>
<td>04 - Masonry Sub</td>
<td>FBE, SBE, DBE, EDGE</td>
<td><a href="mailto:subcontractor@adi.net">subcontractor@adi.net</a></td>
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<tr>
<td>Michael Benza &amp; Associates, Inc.</td>
<td>5880 W. Snowville Rd.</td>
<td>Brecksville</td>
<td>OH</td>
<td>44141</td>
<td>440-526-4205</td>
<td>440-546-2691</td>
<td>01 - Surveying</td>
<td>SBE</td>
<td><a href="mailto:sbenza@remaxagency.com">sbenza@remaxagency.com</a></td>
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<tr>
<td>Company</td>
<td>Address</td>
<td>City</td>
<td>State</td>
<td>Phone</td>
<td>Fax</td>
<td>Nature of Business</td>
<td>Diversity</td>
<td>Email</td>
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<tr>
<td>Midwest Reinforcing Contractors</td>
<td>1839 North Fountain Blvd</td>
<td>Springfield</td>
<td>OH</td>
<td>937-990-9598</td>
<td>937-399-9452</td>
<td>03 - Reinforcing Steel Install, Post-Tensioner</td>
<td>WBE EDGE</td>
<td><a href="mailto:scott@midwestreinforcing.com">scott@midwestreinforcing.com</a></td>
<td></td>
</tr>
<tr>
<td>Mike McGarry &amp; Sons, Inc.</td>
<td>1200 East 49th Street</td>
<td>Cleveland</td>
<td>OH</td>
<td>216-361-1271</td>
<td>216-361-1036</td>
<td>09 - Painting</td>
<td>SBE</td>
<td><a href="mailto:bids@mcmgarryandsons.com">bids@mcmgarryandsons.com</a></td>
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<tr>
<td>Miller Plumbing &amp; Heating Company</td>
<td>195 Bell St</td>
<td>Chagrin Falls</td>
<td>OH</td>
<td>440-247-6446</td>
<td>440-247-0160</td>
<td>15 - HVAC &amp; Plumbing</td>
<td>SBE</td>
<td><a href="mailto:milliepp@aoi.com">milliepp@aoi.com</a></td>
<td></td>
</tr>
<tr>
<td>Minority Electric Co.</td>
<td>200 East 28th Street</td>
<td>Lorain</td>
<td>OH</td>
<td>216-245-2532</td>
<td>216-245-2107</td>
<td>16 - Electrical</td>
<td>MBE SBE</td>
<td><a href="mailto:teamag@centurylink.net">teamag@centurylink.net</a></td>
<td></td>
</tr>
<tr>
<td>Midlum’s Industrial Maintenance, LLC</td>
<td>321 Blackwood Avenue</td>
<td>Dayton</td>
<td>OH</td>
<td>937-507-5258</td>
<td>937-254-1320</td>
<td>02 - Demolition</td>
<td>EDGE/FIRE/SBIE</td>
<td><a href="mailto:btmitchumemari@yahoo.com">btmitchumemari@yahoo.com</a></td>
<td></td>
</tr>
<tr>
<td>Modular Masonry</td>
<td>5920 Centennial Circle, Suite 210</td>
<td>Florence</td>
<td>KY</td>
<td>859-674-2439</td>
<td>859-674-2846</td>
<td>04 - Masonry Sub</td>
<td>WBE</td>
<td></td>
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<tr>
<td>Mohawk Re-bar Services, Inc.</td>
<td>15110 Foltz Parkway - Suite 108</td>
<td>Strongsville</td>
<td>OH</td>
<td>440-268-0780</td>
<td>440-268-0780</td>
<td>03 - Reinforcing Steel Install, Post-Tensioner</td>
<td>MBE SBE</td>
<td><a href="mailto:sales@mohawkrebar.com">sales@mohawkrebar.com</a></td>
<td></td>
</tr>
<tr>
<td>Mondo Mechanical, Inc.</td>
<td>705 Subaru Dr.</td>
<td>Toledo</td>
<td>OH</td>
<td>419-531-7503</td>
<td>419-531-7515</td>
<td>15 - HVAC &amp; Plumbing</td>
<td>MBE EDGE</td>
<td><a href="mailto:robmalou@hotmail.com">robmalou@hotmail.com</a></td>
<td></td>
</tr>
<tr>
<td>MJ Trucking, Inc.</td>
<td>77 E. Wilson Bridge Road</td>
<td>Worthington</td>
<td>OH</td>
<td>614-505-6211</td>
<td>614-505-6242</td>
<td>02 - Trucking</td>
<td>MBE, EDGE, LEDE, DBE</td>
<td><a href="mailto:jmgm@88.truckinginfo.com">jmgm@88.truckinginfo.com</a></td>
<td></td>
</tr>
<tr>
<td>Mull Iron</td>
<td>15 Mull Drive</td>
<td>Pittman</td>
<td>OH</td>
<td>330-927-6855</td>
<td>330-927-1632</td>
<td>05 - Steel &amp; Metals</td>
<td>MBE DBE EDGE</td>
<td><a href="mailto:paul@mulliron.net">paul@mulliron.net</a></td>
<td></td>
</tr>
<tr>
<td>Multicon Fire Containment</td>
<td>1320 McKinley Ave Suite C</td>
<td>Columbus</td>
<td>OH</td>
<td>614-351-2863</td>
<td>614-351-2960</td>
<td>07 - Firestopping</td>
<td>WBE</td>
<td><a href="mailto:rene@multicon.com">rene@multicon.com</a></td>
<td></td>
</tr>
<tr>
<td>Ning Enterprises LLC</td>
<td>793 Tulin Parkway</td>
<td>Broadview Heights</td>
<td>OH</td>
<td>216-262-1114</td>
<td>216-262-8501</td>
<td>02 - Trucking</td>
<td>MBE SBE</td>
<td><a href="mailto:ning488@gmail.com">ning488@gmail.com</a></td>
<td></td>
</tr>
<tr>
<td>North Coast Concrete</td>
<td>6081 Carey Drive</td>
<td>Cleveland</td>
<td>OH</td>
<td>216-642-1114</td>
<td>216-642-3346</td>
<td>03 - Concrete Placement</td>
<td>WBE SBE</td>
<td><a href="mailto:bdbryant@northcoastconcrete.com">bdbryant@northcoastconcrete.com</a></td>
<td></td>
</tr>
<tr>
<td>North Coast Paving</td>
<td>2417 Woodhill Rd</td>
<td>Cleveland</td>
<td>OH</td>
<td>216-421-1203</td>
<td>216-421-1273</td>
<td>02 - Paving, Sidewalk</td>
<td>EDGE SBE</td>
<td><a href="mailto:steve@northcoastpaving.com">steve@northcoastpaving.com</a></td>
<td></td>
</tr>
<tr>
<td>Northcoast Valve &amp; Gate Inc</td>
<td>9437 Mercanti Dr</td>
<td>Mentor</td>
<td>OH</td>
<td>440-392-9910</td>
<td>440-392-9916</td>
<td>11 - Treatment Plant Equipment; 15 - Pipes</td>
<td>WBE SBE</td>
<td><a href="mailto:sales@ncvpg.com">sales@ncvpg.com</a>; <a href="mailto:tonyhales@ncvpg.net">tonyhales@ncvpg.net</a></td>
<td></td>
</tr>
<tr>
<td>Northfield Ohio Trenching Services Inc.</td>
<td>17000 Miles Road</td>
<td>Warrensville Hts.</td>
<td>OH</td>
<td>216-599-7395</td>
<td>216-599-7595</td>
<td>01 - GC; 02 - Sidewalk; 03 - Concrete Placer</td>
<td>MBE DBE EDGE 8a SBE</td>
<td><a href="mailto:service@nhts-excavating.com">service@nhts-excavating.com</a></td>
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</tr>
<tr>
<td>Northstar Contracting, Inc.</td>
<td>11730 Harvard Ave</td>
<td>Cleveland</td>
<td>OH</td>
<td>216-999-7595</td>
<td>216-999-7595</td>
<td>01 - GC; 02 - Sidewalk; 03 - Concrete Placer</td>
<td>MBE DBE EDGE 8a SBE</td>
<td><a href="mailto:stephan@hohomothalp.com">stephan@hohomothalp.com</a></td>
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<tr>
<td>Norwalk Concrete Industries</td>
<td>80 Commerce Drive</td>
<td>Norwalk</td>
<td>OH</td>
<td>419-668-8167</td>
<td>419-668-8267</td>
<td>02 - Precast Structures/Site Pipe</td>
<td>HUBZone</td>
<td><a href="mailto:nrmth@njconprecast.com">nrmth@njconprecast.com</a></td>
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</tr>
<tr>
<td>Nanwood Hardware and Supply Co.</td>
<td>2906 Glendale Milton Road</td>
<td>Cincinnati</td>
<td>OH</td>
<td>513-733-7175</td>
<td>513-733-8076</td>
<td>08 - Doors Frames &amp; Hardware</td>
<td>WBE SBE</td>
<td><a href="mailto:cychabon@nanwoodhardware.com">cychabon@nanwoodhardware.com</a></td>
<td></td>
</tr>
<tr>
<td>NuSsurge Electric Inc.</td>
<td>8100 Grand Ave, Suite 700</td>
<td>Cleveland</td>
<td>OH</td>
<td>216-431-7580</td>
<td>216-431-7581</td>
<td>16 - electrical</td>
<td>MBE, DBE SBE SEDGE</td>
<td><a href="mailto:scott@nuusurge700.com">scott@nuusurge700.com</a></td>
<td></td>
</tr>
<tr>
<td>Oakley Backshop, Inc.</td>
<td>1421 Springfield St</td>
<td>Dayton</td>
<td>OH</td>
<td>937-252-9994</td>
<td>937-252-0047</td>
<td>02 - Paving, Site Concrete</td>
<td>SLS SBE WBE</td>
<td><a href="mailto:pakistan@oic.com">pakistan@oic.com</a></td>
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</tr>
<tr>
<td>OK Interiors Corporation</td>
<td>11000 Ashbum Road</td>
<td>Cincinnati</td>
<td>OH</td>
<td>513-742-3278</td>
<td>513-535-9493</td>
<td>09 - Acoustic Ceiling, Drywall, Access Floor</td>
<td>WBE</td>
<td><a href="mailto:rchneider@okinteriors.com">rchneider@okinteriors.com</a></td>
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</tr>
<tr>
<td>Ontario Stone Corp.</td>
<td>1246 River Road</td>
<td>Cleveland</td>
<td>OH</td>
<td>216-631-1645</td>
<td>216-631-1425</td>
<td>02 - Aggregates</td>
<td>SBE</td>
<td><a href="mailto:victor@ontariostone.com">victor@ontariostone.com</a></td>
<td></td>
</tr>
<tr>
<td>Olsen Plastering</td>
<td>7275 Bridgewater Road</td>
<td>Huber Heights</td>
<td>OH</td>
<td>937-233-7621</td>
<td>937-233-7638</td>
<td>09 - EIFS</td>
<td>SBE WBE</td>
<td><a href="mailto:estimating@orer-usa.com">estimating@orer-usa.com</a></td>
<td></td>
</tr>
<tr>
<td>Osterfield Champion Service, Inc.</td>
<td>121 Commerce Park Drive</td>
<td>Dayton</td>
<td>OH</td>
<td>937-254-8437</td>
<td>937-233-4545</td>
<td>15 - HVAC &amp; Plumbing</td>
<td>DLSB SBE WBE</td>
<td><a href="mailto:bsmith@osterfield.us">bsmith@osterfield.us</a></td>
<td></td>
</tr>
<tr>
<td>Company</td>
<td>Address</td>
<td>City</td>
<td>State</td>
<td>Zip</td>
<td>Phone</td>
<td>Fax</td>
<td>Nature of Business</td>
<td>Diversity</td>
<td>Email</td>
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<tr>
<td>Overhead Door Company of Greater Pittsburgh</td>
<td>400 Poplar Street</td>
<td>Pittsburgh</td>
<td>PA</td>
<td>15223</td>
<td>412-781-4000</td>
<td>412-781-2446</td>
<td>08 - Overhead Coiling Doors</td>
<td>SDVOSB</td>
<td><a href="mailto:amuerks@ohdpg.com">amuerks@ohdpg.com</a></td>
</tr>
<tr>
<td>P.G.T. Construction Inc.</td>
<td>9900 York Theta Drive, Suite B</td>
<td>North Royalton</td>
<td>OH</td>
<td>44133</td>
<td>440-237-1155</td>
<td>440-877-3012</td>
<td>02 - Trucking</td>
<td>WBE SBE</td>
<td>pmw@truckpig Мытн</td>
</tr>
<tr>
<td>Patriot Construction Service</td>
<td>3111 N Martela Drive</td>
<td>Akron</td>
<td>OH</td>
<td>44333</td>
<td>330-665-5267</td>
<td>330-666-3512</td>
<td>05 - Millwork; 08 - Doors Frames &amp; Hardware</td>
<td>SDVOSB</td>
<td><a href="mailto:thm@patriotcarpenter.com">thm@patriotcarpenter.com</a></td>
</tr>
<tr>
<td>Pavement Management, Inc.</td>
<td>4014 Colfax Avenue</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45223</td>
<td>513-531-0303</td>
<td>513-531-0381</td>
<td>02 - Paving</td>
<td>SBE</td>
<td><a href="mailto:pmr@pavement1st.com">pmr@pavement1st.com</a></td>
</tr>
<tr>
<td>Penn-O-Ho Iron Works Inc.</td>
<td>PO Box 20054</td>
<td>Farrell</td>
<td>PA</td>
<td>16121</td>
<td>855-982-0957</td>
<td>724-982-0957</td>
<td>07 - Roofing and Sheet Metal; 03 - Rebar In</td>
<td>MBE</td>
<td><a href="mailto:pennpfefer@comcast.com">pennpfefer@comcast.com</a></td>
</tr>
<tr>
<td>Penguin Painters, Inc.</td>
<td>6516 Madison Rd</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45227</td>
<td>513-271-5404</td>
<td>513-271-5403</td>
<td>09 - Painting</td>
<td>MBE WBE SBE</td>
<td><a href="mailto:echermin@penguinpainters.com">echermin@penguinpainters.com</a></td>
</tr>
<tr>
<td>Perry Interiors, Inc.</td>
<td>4054 Clough Woods Dr.</td>
<td>Batavia</td>
<td>OH</td>
<td>45103</td>
<td>513-761-0303</td>
<td>513-761-4039</td>
<td>09 - Painting</td>
<td>WBE EDGE</td>
<td><a href="mailto:perry@peminters.com">perry@peminters.com</a></td>
</tr>
<tr>
<td>Pete and Pete Container Service, Inc.</td>
<td>4830 Warner Rd</td>
<td>Garfield Hts</td>
<td>OH</td>
<td>44125</td>
<td>216-441-4422</td>
<td>216-441-4408</td>
<td>01 - Dumpsters; Waste Removal</td>
<td>FBE, RSB, EDGE</td>
<td><a href="mailto:lisa@peteandpeteinc.com">lisa@peteandpeteinc.com</a></td>
</tr>
<tr>
<td>Petty Group LLC</td>
<td>550 Harvard Ave., Read</td>
<td>Cuyahoga Heights</td>
<td>OH</td>
<td>44105</td>
<td>216-206-2600</td>
<td>216-206-2325</td>
<td>02 - Fence</td>
<td>MBE EDGE</td>
<td><a href="mailto:bme.pettygroup@gmail.com">bme.pettygroup@gmail.com</a></td>
</tr>
<tr>
<td>Pittsburgh Premier Construction</td>
<td>1915 Walle Street</td>
<td>Pittsburgh</td>
<td>PA</td>
<td>15210</td>
<td>412-481-3060</td>
<td>412-481-3061</td>
<td>04 - Masonry Sub</td>
<td>MBE WBE</td>
<td></td>
</tr>
<tr>
<td>Plantscaping Inc.</td>
<td>1855 East 40th Street</td>
<td>Cleveland</td>
<td>OH</td>
<td>44117</td>
<td>216-367-1200</td>
<td>216-367-1211</td>
<td>02 - Landscaping</td>
<td>WBE SBE</td>
<td><a href="mailto:nam@plantscaping.com">nam@plantscaping.com</a></td>
</tr>
<tr>
<td>Post Painting Inc.</td>
<td>24815 Aurora Road</td>
<td>Bedford Heights</td>
<td>OH</td>
<td>44146</td>
<td>440-439-6808</td>
<td>440-430-3011</td>
<td>09 - Painting</td>
<td>WBE SBE</td>
<td><a href="mailto:bunci@postpaintings.com">bunci@postpaintings.com</a></td>
</tr>
<tr>
<td>PPW Builders Inc.</td>
<td>11875 Bellaire Road</td>
<td>Cleveland</td>
<td>OH</td>
<td>44135</td>
<td>216-862-1677</td>
<td>216-862-1676</td>
<td>01 - GIC</td>
<td>WBE SBE</td>
<td><a href="mailto:sandy@ppwbuilders.com">sandy@ppwbuilders.com</a></td>
</tr>
<tr>
<td>Precision Directional Boring LLC</td>
<td>740 Merco Road</td>
<td>Valley City</td>
<td>OH</td>
<td>44280</td>
<td>330-220-1274</td>
<td>330-273-6400</td>
<td>02 - Drilling</td>
<td>WBE SBE</td>
<td><a href="mailto:gdb07030@gmail.com">gdb07030@gmail.com</a></td>
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<tr>
<td>Premiere Renovations, Inc.</td>
<td>22050 Miles</td>
<td>North Randall</td>
<td>OH</td>
<td>44128</td>
<td>216-292-7428</td>
<td>216-322-1130</td>
<td>09 - Finishes</td>
<td>MBE SBE</td>
<td><a href="mailto:nphilp175@yahoo.com">nphilp175@yahoo.com</a></td>
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<tr>
<td>Price Corp Group LLC</td>
<td>23103 Miles Rd., Suite 300</td>
<td>Cleveland</td>
<td>OH</td>
<td>44128</td>
<td>216-475-8112</td>
<td>216-475-8113</td>
<td>01 - Construction Clean Up</td>
<td>MBE DBE SBEUCP</td>
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<tr>
<td>Professional Masonry Services, LLC</td>
<td>954 North Bend Road Suite 301</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45204</td>
<td>513-310-8873</td>
<td>513-522-0123</td>
<td>04 - Masonry Restoration</td>
<td>SBE, MBE, EDGE</td>
<td><a href="mailto:professionalmasonryservices@yahoo.com">professionalmasonryservices@yahoo.com</a></td>
</tr>
<tr>
<td>Progressive Industries, Inc.</td>
<td>2730 N. Pulaski Ave.</td>
<td>Chicago</td>
<td>IL</td>
<td>60639</td>
<td>773-537-6500</td>
<td>773-763-9587</td>
<td>10 - Specialties; 15 - Pipes &amp; Valves</td>
<td>WBE DBE HUBZone</td>
<td><a href="mailto:professional@progressiveapi.com">professional@progressiveapi.com</a></td>
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<tr>
<td>Project Skills, Inc.</td>
<td>1390 Grand Avenue</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45214</td>
<td>513-921-4141</td>
<td>513-921-4010</td>
<td>07 - Waterproofing and Joint Sealants</td>
<td>SBE</td>
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<tr>
<td>Protective Coatings</td>
<td>4331 Webster Street</td>
<td>Dayton</td>
<td>OH</td>
<td>45414</td>
<td>937-275-7711</td>
<td>937-275-7726</td>
<td>09 - Painting</td>
<td>EDGE SBE, DLSS</td>
<td><a href="mailto:kc@sci-comp.biz">kc@sci-comp.biz</a></td>
</tr>
<tr>
<td>ProPella Inc.</td>
<td>29100 Euclid Avenue</td>
<td>Cleveland</td>
<td>OH</td>
<td>44092</td>
<td>440-478-2422</td>
<td>440-383-6444</td>
<td>02 - Trucking</td>
<td>SBE</td>
<td><a href="mailto:everest20@hotmail.com">everest20@hotmail.com</a></td>
</tr>
<tr>
<td>Qual-Air HVAC, Inc.</td>
<td>18791 SR 301</td>
<td>Lago Grande</td>
<td>OH</td>
<td>44050</td>
<td>440-341-1745</td>
<td>440-355-6291</td>
<td>15 - HVAC</td>
<td>SBE</td>
<td><a href="mailto:qualairhvac@windstream.net">qualairhvac@windstream.net</a></td>
</tr>
<tr>
<td>Quality Fire Protection</td>
<td>11200 LaBrie Road</td>
<td>Aurora</td>
<td>IN</td>
<td>47001</td>
<td>812-926-1625</td>
<td>812-926-1325</td>
<td>15 - Fire Protection</td>
<td>WBE</td>
<td><a href="mailto:qualityfire@emberandmall.com">qualityfire@emberandmall.com</a></td>
</tr>
<tr>
<td>Quality Interiors Inc.</td>
<td>3745 N. Kilby Avenue</td>
<td>Indianapolis</td>
<td>IN</td>
<td>46226</td>
<td>317-713-7050</td>
<td>317-713-7055</td>
<td>09 - Acoustic Ceiling, Drywall, Resinous Floe</td>
<td>MBE</td>
<td><a href="mailto:bidetersil@ho.com">bidetersil@ho.com</a></td>
</tr>
<tr>
<td>Queen City Blacktop</td>
<td>1647 Westwood Avenue</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45214</td>
<td>513-251-8400</td>
<td>513-537-4132</td>
<td>02 - Paving</td>
<td>SBE</td>
<td><a href="mailto:office@queencityblacktop.com">office@queencityblacktop.com</a></td>
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<tr>
<td>Queen City Fence Contracting</td>
<td>10100 Springfield Pike</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45215</td>
<td>513-761-5386</td>
<td>516-772-7400</td>
<td>02 - Fence</td>
<td>SBE</td>
<td><a href="mailto:orlic@law.net">orlic@law.net</a></td>
</tr>
<tr>
<td>Company</td>
<td>Address</td>
<td>City</td>
<td>State</td>
<td>Zip</td>
<td>Phone</td>
<td>Fax</td>
<td>Nature of Business</td>
<td>Diversity</td>
<td>Email</td>
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<tr>
<td>R. L. Cole Enterprise Inc.</td>
<td>2504 East 124th</td>
<td>Cleveland</td>
<td>OH</td>
<td>44120</td>
<td>216-707-9550</td>
<td>216-707-9537</td>
<td>02 - Landscaping</td>
<td>MBE</td>
<td><a href="mailto:ricoleenterpriseinc@gmail.com">ricoleenterpriseinc@gmail.com</a></td>
</tr>
<tr>
<td>R.H. Cochran &amp; Associates, Inc.</td>
<td>30133 Euclid Ave., Suite B</td>
<td>Wickliffe</td>
<td>OH</td>
<td>44002</td>
<td>(440) 585-5940</td>
<td>(440) 585-5942</td>
<td>15 - HVAC &amp; Plumbing</td>
<td>DBEUCP</td>
<td><a href="mailto:cochranchance@lath.net">cochranchance@lath.net</a></td>
</tr>
<tr>
<td>Rainbow Environmental Services, Inc.</td>
<td>4723 Red Bank Rd.</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45227</td>
<td>513-624-6470</td>
<td>513-231-0301</td>
<td>02 - Demolition, Remediation</td>
<td>EDGE</td>
<td><a href="mailto:info@rainbow-environmental.com">info@rainbow-environmental.com</a></td>
</tr>
<tr>
<td>RAR Contracting Inc.</td>
<td>5545 Canal Rd</td>
<td>Valley View</td>
<td>OH</td>
<td>44125</td>
<td>216-857-5820</td>
<td>440-725-3946</td>
<td>03 - Ready Mix</td>
<td>MBE, DBE, SBE, CSB, EDGE, CMHA</td>
<td><a href="mailto:rarscontractingco@gmail.com">rarscontractingco@gmail.com</a></td>
</tr>
<tr>
<td>R-Cap Security</td>
<td>540 E. 105th St Suite 250</td>
<td>Cleveland</td>
<td>OH</td>
<td>44108</td>
<td>216-881-7743</td>
<td>216-881-7704</td>
<td>01 - Security</td>
<td>FBE</td>
<td></td>
</tr>
<tr>
<td>Real Science Inc.</td>
<td>9520 Frederick Pike</td>
<td>Dayton</td>
<td>OH</td>
<td>45414</td>
<td>937-576-0025</td>
<td>937-847-2715</td>
<td>01 - Testing and Inspection; 02 - Asbestos A</td>
<td>WBE</td>
<td><a href="mailto:chris@realscienceinc.com">chris@realscienceinc.com</a></td>
</tr>
<tr>
<td>Pelmac Mechanical LLC</td>
<td>4975 Hamilton Avenue</td>
<td>Cleveland</td>
<td>OH</td>
<td>44114</td>
<td>216-391-1030</td>
<td>216-391-1817</td>
<td>15 - HVAC &amp; Plumbing</td>
<td>WBE</td>
<td><a href="mailto:avana@erhmaci.com">avana@erhmaci.com</a></td>
</tr>
<tr>
<td>Renasscent Inc.</td>
<td>935 W. Troy Ave.</td>
<td>Indianapolis</td>
<td>IN</td>
<td>46225</td>
<td>317-783-1500</td>
<td>317-783-4600</td>
<td>02 - Demolition</td>
<td>WBE</td>
<td><a href="mailto:dawne@renasscentinc.com">dawne@renasscentinc.com</a></td>
</tr>
<tr>
<td>Resilient Construction Group</td>
<td>8186 Byers Rd.</td>
<td>Miamisburg</td>
<td>OH</td>
<td>45242</td>
<td>937-902-8648</td>
<td>937-847-2715</td>
<td>09 - Drywall</td>
<td>WBE SBE</td>
<td><a href="mailto:rsb@resilientconstruction.com">rsb@resilientconstruction.com</a></td>
</tr>
<tr>
<td>Resource International, Inc.</td>
<td>9885 Rockside Road, Suite 145</td>
<td>Cleveland</td>
<td>OH</td>
<td>44125</td>
<td>216-576-0995</td>
<td>216-576-1887</td>
<td>01 - Testing and Inspection</td>
<td>MBE WBE SBE</td>
<td>resourcesinternational.com</td>
</tr>
<tr>
<td>River City Furniture</td>
<td>6454 Centre Park Drive</td>
<td>West Chester</td>
<td>OH</td>
<td>45060</td>
<td>513-612-7254</td>
<td>513-612-7313</td>
<td>09 - Flooring</td>
<td>EDGE MBE</td>
<td></td>
</tr>
<tr>
<td>RJ Flaten Contracting Company</td>
<td>14490 York Rd.</td>
<td>North Royalton</td>
<td>OH</td>
<td>44133</td>
<td>440-237-8070</td>
<td>440-237-1887</td>
<td>01 - Steelwork, Site Concrete; 03 - Concrete</td>
<td>SBE</td>
<td><a href="mailto:ajflaten@spacetenncon.com">ajflaten@spacetenncon.com</a></td>
</tr>
<tr>
<td>RL Cole Enterprise, Inc.</td>
<td>PO Box 22088</td>
<td>Beachwood</td>
<td>OH</td>
<td>44122</td>
<td>216-707-9550</td>
<td>216-707-9537</td>
<td>02 - Trucking, Aggregates</td>
<td>FBE, MBE, SBE, CSB, EDGE</td>
<td><a href="mailto:ricolcoleenterpriseinc@gmail.com">ricolcoleenterpriseinc@gmail.com</a></td>
</tr>
<tr>
<td>RMI Cement LLC</td>
<td>2213 Gage Ave. NE</td>
<td>Canton</td>
<td>OH</td>
<td>44705</td>
<td>(330) 452-1043</td>
<td>(330) 452-9901</td>
<td>03 - Concrete Placement</td>
<td>DBEUCP</td>
<td></td>
</tr>
<tr>
<td>Roberts Service Group</td>
<td>820 N. Hague Ave.</td>
<td>Columbus</td>
<td>OH</td>
<td>43204</td>
<td>614-276-0126</td>
<td>614-276-0510</td>
<td>15 - HVAC &amp; Plumbing</td>
<td>WBE EDGE</td>
<td><a href="mailto:tim@robertsandco.com">tim@robertsandco.com</a></td>
</tr>
<tr>
<td>Rockport Ready Mix</td>
<td>3092 Rockefeller Ave</td>
<td>Cleveland</td>
<td>OH</td>
<td>44115</td>
<td>440-349-1528</td>
<td>216-359-0111</td>
<td>03 - Ready Mix</td>
<td>DBE, FBE, CSB, EDGE</td>
<td></td>
</tr>
<tr>
<td>Rod-Techs, Inc.</td>
<td>PO Box 101</td>
<td>Milford</td>
<td>OH</td>
<td>45239</td>
<td>513-522-1124</td>
<td>513-522-1204</td>
<td>03 - Reinforcing Steel Install</td>
<td>DBE MBE SBE EDGE</td>
<td><a href="mailto:chrispacker@rodtechs.org">chrispacker@rodtechs.org</a></td>
</tr>
<tr>
<td>Roma Designs Construction, LLC</td>
<td>6414 St. Clair Ave.</td>
<td>Cleveland</td>
<td>OH</td>
<td>44103</td>
<td>216-751-7888</td>
<td>216-431-0301</td>
<td>08 - Doors Frames &amp; Hardware; 03 - Accoust</td>
<td>MBE</td>
<td><a href="mailto:elhanks@romadesignsconstruction.com">elhanks@romadesignsconstruction.com</a></td>
</tr>
<tr>
<td>Ron Hall's Famous Final Cleaning</td>
<td>2520 Pleasant Ave</td>
<td>Hamilton</td>
<td>OH</td>
<td>45015</td>
<td>513-237-7575</td>
<td>513-857-0036</td>
<td>01 - Construction Clean Up</td>
<td>DBE</td>
<td></td>
</tr>
<tr>
<td>Royal Landscape-Gardening Inc.</td>
<td>7801 Old Granger Road</td>
<td>Cleveland</td>
<td>OH</td>
<td>44124</td>
<td>216-883-7000</td>
<td>216-883-7773</td>
<td>02 - Landscaping</td>
<td>WBE SBE</td>
<td><a href="mailto:royals@royalcompanies.net">royals@royalcompanies.net</a></td>
</tr>
<tr>
<td>RVI, Inc.</td>
<td>P.O Box 929</td>
<td>Wooster</td>
<td>OH</td>
<td>44691</td>
<td>330-263-6852</td>
<td>330-263-1723</td>
<td>02 - Hydro Excavation, Solids Disposal, Tar</td>
<td>WBE</td>
<td><a href="mailto:rvlri33@gmail.com">rvlri33@gmail.com</a></td>
</tr>
<tr>
<td>RWI Wiring Inc.</td>
<td>23880 Puritan Road</td>
<td>Cleveland</td>
<td>OH</td>
<td>44123</td>
<td>216-261-7955</td>
<td>216-261-7955</td>
<td>13 - Instrumentation &amp; Controls; 16 - Electrical</td>
<td>MBE</td>
<td><a href="mailto:mchais@newenginc.com">mchais@newenginc.com</a></td>
</tr>
<tr>
<td>Ryan Carpet Sales &amp; Service</td>
<td>70 Victoria Road</td>
<td>Austintown</td>
<td>OH</td>
<td>44515</td>
<td>330-792-1442</td>
<td>330-792-8558</td>
<td>09 - Flooring</td>
<td>WBE</td>
<td><a href="mailto:info@wagcarpet.com">info@wagcarpet.com</a></td>
</tr>
<tr>
<td>S. Lockwood Trucking &amp; Cab, Inc.</td>
<td>5707 Orchard Avenue</td>
<td>Parma</td>
<td>OH</td>
<td>44129</td>
<td>216-440-0408</td>
<td>440-882-3038</td>
<td>02 - Trucking</td>
<td>WBE SBE</td>
<td><a href="mailto:steveatlockridge@yahoo.com">steveatlockridge@yahoo.com</a></td>
</tr>
<tr>
<td>Sadie's Wholesale &amp; Construction, Inc.</td>
<td>728 Park Avenue East PO Box 1266</td>
<td>Mansfield</td>
<td>OH</td>
<td>44901-1266</td>
<td>419-524-7973</td>
<td>419-524-7974</td>
<td>15 - Pipes &amp; Valves; 03 - Construction Suppl</td>
<td>MBE WBE SDB</td>
<td><a href="mailto:sadie_s@sallieswholesale.com">sadie_s@sallieswholesale.com</a></td>
</tr>
<tr>
<td>Company</td>
<td>Address</td>
<td>City</td>
<td>State</td>
<td>Zip</td>
<td>Phone</td>
<td>Fax</td>
<td>Nature of Business</td>
<td>Diversity</td>
<td>Email</td>
</tr>
<tr>
<td>----------------------------------</td>
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</tr>
<tr>
<td>Sampson Maintenance Services, Inc.</td>
<td>1851 Wilson Ave</td>
<td>Youngstown</td>
<td>OH</td>
<td>44501</td>
<td>330-533-5852</td>
<td>330-533-7705</td>
<td>09 - Painting</td>
<td>WBE SBE</td>
<td><a href="mailto:npontikos@aol.com">npontikos@aol.com</a></td>
</tr>
<tr>
<td>Samson Steel Corporation</td>
<td>1414 Galbraith Road</td>
<td>Frankfort</td>
<td>KY</td>
<td>40601</td>
<td>502-635-5715</td>
<td>502-635-5715</td>
<td>03 - Reinforcing Steel Install</td>
<td>WBE(selfcert)</td>
<td><a href="mailto:bruhoe@crosscountry.net">bruhoe@crosscountry.net</a></td>
</tr>
<tr>
<td>Scharton Electric Co., Inc.</td>
<td>28730 Cannon Road</td>
<td>Solon</td>
<td>OH</td>
<td>44139</td>
<td>440-248-3300</td>
<td>440-248-3362</td>
<td>16 - Electrical</td>
<td>WBE SBE</td>
<td><a href="mailto:escharton@schartonelectric.net">escharton@schartonelectric.net</a></td>
</tr>
<tr>
<td>Scheringer Drilling</td>
<td>9629 State Route 128 PO Box 202</td>
<td>Miamisburg</td>
<td>OH</td>
<td>45410</td>
<td>513-738-2003</td>
<td>513-738-3100</td>
<td>02 - Deep Foundations, Shoring, Grauling</td>
<td>SBE</td>
<td><a href="mailto:info@scheringerdrilling.com">info@scheringerdrilling.com</a></td>
</tr>
<tr>
<td>Schnell Contractors Inc.</td>
<td>1343 Tile Factory Lane</td>
<td>Louisville</td>
<td>KY</td>
<td>40213</td>
<td>502-989-7354</td>
<td>502-968-3445</td>
<td>07 - Waterproofing and Joint Sealants; 03 - I</td>
<td>MBE SBE</td>
<td></td>
</tr>
<tr>
<td>Schweitzer Construction Co</td>
<td>PO Box 15428 325 Clark Road</td>
<td>Cincinnati</td>
<td>KY</td>
<td>45215</td>
<td>513-761-0480</td>
<td>513-761-0418</td>
<td>01 - Equipment Rental</td>
<td>SBE</td>
<td></td>
</tr>
<tr>
<td>Security Fence Group, Inc.</td>
<td>4260 Dana Avenue</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45223</td>
<td>513-681-3700</td>
<td>513-681-5487</td>
<td>02 - Fence</td>
<td>WBE SBE EDGE DBEUCP</td>
<td><a href="mailto:diane@sfence.com">diane@sfence.com</a></td>
</tr>
<tr>
<td>Security Fence Group, Inc.</td>
<td>5846 Poe Ave</td>
<td>Dayton</td>
<td>OH</td>
<td>45414</td>
<td>937-898-7008</td>
<td>937-898-0009</td>
<td>02 - Fence</td>
<td>WBE SBE EDGE DBEUCP</td>
<td><a href="mailto:sbrown@sfence.com">sbrown@sfence.com</a></td>
</tr>
<tr>
<td>SEPI Trucking Services</td>
<td>4255 Old Wheeling Rd</td>
<td>Zanesville</td>
<td>OH</td>
<td>43701</td>
<td>740-453-7274</td>
<td>740-455-8153</td>
<td>02 - Trucking</td>
<td>DBE, EDGE, HUB, WBE</td>
<td><a href="mailto:expservices@hotmail.com">expservices@hotmail.com</a></td>
</tr>
<tr>
<td>Sippel Steel Fab</td>
<td>2100 Georgetown Dr., Suite 101</td>
<td>Sewickley</td>
<td>PA</td>
<td>15143</td>
<td>724-934-4800</td>
<td>724-934-4801</td>
<td>05 - Steel &amp; Metals</td>
<td>SBE</td>
<td><a href="mailto:galewisk@galewiskfab.com">galewisk@galewiskfab.com</a></td>
</tr>
<tr>
<td>Soil Testing &amp; Engineering, Ltd</td>
<td>6375 Shier Pkg Rd Ste F</td>
<td>Dublin</td>
<td>OH</td>
<td>43016</td>
<td>614-761-4700</td>
<td>614-761-6630</td>
<td>01 - Testing and Inspection</td>
<td>MBE SBE</td>
<td><a href="mailto:bernhardt@nordiclab.com">bernhardt@nordiclab.com</a></td>
</tr>
<tr>
<td>Solar Testing Laboratories Inc.</td>
<td>1125 Valley Bell Road</td>
<td>Brooklyn Heights</td>
<td>OH</td>
<td>44131</td>
<td>216-741-7007</td>
<td>216-741-7011</td>
<td>01 - Testing and Inspection</td>
<td>SBE</td>
<td><a href="mailto:mkg@ohio.com">mkg@ohio.com</a></td>
</tr>
<tr>
<td>Solfin Electric Co.</td>
<td>310 East Russell Road</td>
<td>Sidney</td>
<td>OH</td>
<td>43505</td>
<td>937-492-0346</td>
<td>937-492-4447</td>
<td>16 - Electrical</td>
<td>HUBZone, VOSB</td>
<td></td>
</tr>
<tr>
<td>Somal Engineering of Ohio Inc.</td>
<td>1100 Superior Avenue, Suite 202</td>
<td>Cleveland</td>
<td>OH</td>
<td>44114</td>
<td>216-479-0300</td>
<td>216-479-0301</td>
<td>01 - Surveying,Testing and Inspection</td>
<td>MBE SBE</td>
<td><a href="mailto:bleibarc@somalengineering.com">bleibarc@somalengineering.com</a></td>
</tr>
<tr>
<td>SOS Integration</td>
<td>526 S. Main Street Suite 412</td>
<td>Akron</td>
<td>OH</td>
<td>44311</td>
<td>330-294-0089</td>
<td>330-294-0094</td>
<td>13 - Instrumentation &amp; Controls</td>
<td>SBE</td>
<td><a href="mailto:akublu@wissmaninc.com">akublu@wissmaninc.com</a></td>
</tr>
<tr>
<td>SP Drilling Services, Inc.</td>
<td>103 Mound Avenue</td>
<td>Milford</td>
<td>OH</td>
<td>45150</td>
<td>513-831-7412</td>
<td>513-831-4370</td>
<td>02 - Drilling</td>
<td>DBE</td>
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</tr>
<tr>
<td>Sparks Professional Services</td>
<td>418 Main Ave. SW. Suite 203 Room Warren</td>
<td>OH</td>
<td>44461</td>
<td>330-553-6444</td>
<td>330-372-6516</td>
<td>02 - Trucking</td>
<td>DBE, process of renewing MBE/EDGE</td>
<td><a href="mailto:sparkspservices@hotmail.com">sparkspservices@hotmail.com</a></td>
<td></td>
</tr>
<tr>
<td>Spectrum Commercial Coatings</td>
<td>861 Camden Ave</td>
<td>Columbus</td>
<td>OH</td>
<td>43221</td>
<td>614-754-8145</td>
<td>614-754-8253</td>
<td>09 - Painting, Epoxy Floors</td>
<td>WBE</td>
<td><a href="mailto:spectrum@spectrumpaint.com">spectrum@spectrumpaint.com</a></td>
</tr>
<tr>
<td>Speedy Maintenance Services</td>
<td>1526 Elm Street, Suite 1</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45202</td>
<td>513-684-0419</td>
<td>513-684-0708</td>
<td>04 - Masonry Sub</td>
<td>SBE</td>
<td><a href="mailto:speedymaintenance@weeholts.com">speedymaintenance@weeholts.com</a></td>
</tr>
<tr>
<td>Springfield Plumbing, Inc.</td>
<td>1903 W. Market Street</td>
<td>Louisville</td>
<td>KY</td>
<td>40203</td>
<td>502-587-8281</td>
<td>502-587-6299</td>
<td>15 - Plumbing</td>
<td>MBE</td>
<td></td>
</tr>
<tr>
<td>Spurta Insulation Materials</td>
<td>4000 Oxford State Road</td>
<td>Middletown</td>
<td>OH</td>
<td>45044</td>
<td>513-422-6677</td>
<td>513-422-6678</td>
<td>03 - Ready Mix</td>
<td>SBE</td>
<td><a href="mailto:spassan@spurta.com">spassan@spurta.com</a></td>
</tr>
<tr>
<td>Standard Contracting &amp; Engineering, Inc.</td>
<td>6356 Eastland Road, Brook Park</td>
<td>OH</td>
<td>44142</td>
<td>440-243-1001</td>
<td>440-243-1415</td>
<td>05 - Steel &amp; Metals</td>
<td>SBE CSB</td>
<td>spney@<a href="mailto:spney@standardcontracting.com">spney@standardcontracting.com</a></td>
<td></td>
</tr>
<tr>
<td>Summit Fence Supply, LLC</td>
<td>1424 Waters Edge Dr</td>
<td>Akron</td>
<td>OH</td>
<td>44313</td>
<td>330-923-4214</td>
<td>880-841-8023</td>
<td>02 - Fence</td>
<td>EDGE</td>
<td><a href="mailto:svult@summitfencesupply.com">svult@summitfencesupply.com</a></td>
</tr>
<tr>
<td>Summit Painting</td>
<td>1520 East 365th St, Unit A</td>
<td>Eastlake</td>
<td>OH</td>
<td>44095</td>
<td>440-209-8998</td>
<td>440-260-8997</td>
<td>09 - Painting</td>
<td>WBE SBE</td>
<td><a href="mailto:bigwump@bigwump.com">bigwump@bigwump.com</a></td>
</tr>
<tr>
<td>Superior Enterprises Unlimited, LLC</td>
<td>2389 Refugee Park</td>
<td>Columbus</td>
<td>OH</td>
<td>43207</td>
<td>614-252-7250</td>
<td>614-252-7253</td>
<td>02 - Sitework, Demolition, Trucking; 13 - M</td>
<td>MBE, EDGE, LEDE</td>
<td><a href="mailto:sekronik@swvulc.com">sekronik@swvulc.com</a></td>
</tr>
<tr>
<td>Superior Industrial Insulation</td>
<td>3280 East 11th Ave</td>
<td>Columbus</td>
<td>OH</td>
<td>43219</td>
<td>614-429-3618</td>
<td>614-383-7046</td>
<td>07 - Insulation, Firestopping, Fireproofing; 17</td>
<td>SBE</td>
<td><a href="mailto:tldale@superior-insulation.com">tldale@superior-insulation.com</a></td>
</tr>
<tr>
<td>Company</td>
<td>Address</td>
<td>City</td>
<td>State</td>
<td>Zip</td>
<td>Phone</td>
<td>Fax</td>
<td>Nature of Business</td>
<td>Diversity</td>
<td>Email</td>
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<tr>
<td>----------------------------------------------</td>
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</tr>
<tr>
<td>Superior Industrial Insulation</td>
<td>3855 West 150th Street</td>
<td>Cleveland</td>
<td>OH</td>
<td>44111</td>
<td>216-252-9500</td>
<td>216-252-9481</td>
<td>07 - Insulation, Firestopping, Fireproofing; 17</td>
<td>SBE NEOSID CSB</td>
<td><a href="mailto:blake@superior-insulation.com">blake@superior-insulation.com</a></td>
</tr>
<tr>
<td>Superior Laboratory Systems, Inc.</td>
<td>998 East Ridge Dr. Suite E</td>
<td>Lebanon</td>
<td>OH</td>
<td>45036</td>
<td>513-934-3979</td>
<td>513-934-3879</td>
<td>12 - Lab Casework</td>
<td>MBE EDGE</td>
<td><a href="mailto:superlab@go-concepts.com">superlab@go-concepts.com</a></td>
</tr>
<tr>
<td>T &amp; B Electric, Ltd.</td>
<td>7464 Walford Road</td>
<td>Denton</td>
<td>OH</td>
<td>43061</td>
<td>740-881-5696</td>
<td>740-881-0999</td>
<td>15 - Electrical</td>
<td>WBE</td>
<td><a href="mailto:zmchols@thelectric.com">zmchols@thelectric.com</a></td>
</tr>
<tr>
<td>T&amp;F Systems, Inc.</td>
<td>1559 East 40th St</td>
<td>Cleveland</td>
<td>OH</td>
<td>44103</td>
<td>216-881-3525</td>
<td>216-881-6763</td>
<td>07 - Roofing and Sheet Metal</td>
<td>SBE</td>
<td><a href="mailto:tfsystems@tfsystems.com">tfsystems@tfsystems.com</a></td>
</tr>
<tr>
<td>Tall View Paintalum Inc.</td>
<td>1728 Troy St</td>
<td>Dayton</td>
<td>OH</td>
<td>45404</td>
<td>907-256-8586</td>
<td>907-220-9912</td>
<td>02 - Painting, Aggregates, Trucking, Roll-off C</td>
<td>DLB SBE MBE</td>
<td><a href="mailto:tehnpaintalum@theborglobal.net">tehnpaintalum@theborglobal.net</a></td>
</tr>
<tr>
<td>Taylor Bros. Construction Co., Inc.</td>
<td>4555 Middle Rd.</td>
<td>Columbus</td>
<td>OH</td>
<td>41720</td>
<td>812-379-9547</td>
<td>812-372-4759</td>
<td>12 - Retail Fixturing, 01 - GC, General Trade</td>
<td>MBE</td>
<td><a href="mailto:ichandler@tbcci.com">ichandler@tbcci.com</a></td>
</tr>
<tr>
<td>Tech Ready Mix</td>
<td>5000 Creyon Ave</td>
<td>Cleveland</td>
<td>OH</td>
<td>44111</td>
<td>216-218-5431</td>
<td>216-261-2270</td>
<td>03 - Ready Mix</td>
<td>MBE,CSB, SBE,EDGE</td>
<td><a href="mailto:diogarci@techreadyweb.com">diogarci@techreadyweb.com</a></td>
</tr>
<tr>
<td>TexTech</td>
<td>8534 Yankee Street</td>
<td>Dayton</td>
<td>OH</td>
<td>45458</td>
<td>507-435-3200</td>
<td>507-291-6549</td>
<td>01 - Testing and Inspection</td>
<td>SBE MBE EDGE</td>
<td><a href="mailto:gregory@textechinc.com">gregory@textechinc.com</a></td>
</tr>
<tr>
<td>The And Company</td>
<td>3535 Johnny Appleseed Court</td>
<td>Columbus</td>
<td>OH</td>
<td>43231</td>
<td>614-895-3535</td>
<td>614-895-7045</td>
<td>09 - Flooring (Tile &amp; Terrazo Only)</td>
<td>WBE</td>
<td><a href="mailto:estimating@andcompany.com">estimating@andcompany.com</a></td>
</tr>
<tr>
<td>The Jadi Group</td>
<td>4500 Lee Road, Suite 231</td>
<td>Cleveland</td>
<td>OH</td>
<td>44128</td>
<td>216-518-4878</td>
<td>216-701-9502</td>
<td>02 - Landscaping</td>
<td>MBE SBE</td>
<td><a href="mailto:thejadi@theborgglobal.net">thejadi@theborgglobal.net</a></td>
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<tr>
<td>The TorMaxx Co</td>
<td>1150 W 8th St Suite 111</td>
<td>Cincinnati</td>
<td>OH</td>
<td>45203</td>
<td>513-721-6299</td>
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<td>ThermalTech Insulation, Inc.</td>
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<td>OH</td>
<td>45344</td>
<td>937-845-3696</td>
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<td><a href="mailto:thermaltechinsulation13@gmail.com">thermaltechinsulation13@gmail.com</a></td>
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<td>44105</td>
<td>216-663-3842</td>
<td>216-663-3843</td>
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<td>3630 East 103rd Street</td>
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<td>216-429-0321</td>
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<td>homestead1@<a href="mailto:393landscaping@yahoo.com">393landscaping@yahoo.com</a></td>
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<td>Timeline Photography</td>
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<td>Warrensville</td>
<td>KY</td>
<td>44128</td>
<td>440-476-1535</td>
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<td>Titan Commercial Flooring</td>
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<td>45315</td>
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<td>diphart@<a href="mailto:titanflooring@gmail.com">titanflooring@gmail.com</a></td>
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<td>Tri-State CFSC, LLC</td>
<td>140 Arnold Drive Suite 1</td>
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<td>41065</td>
<td>502-957-1234</td>
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<td>45679</td>
<td>937-695-4094</td>
<td>937-695-6094</td>
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<td><a href="mailto:instalation@localnet.com">instalation@localnet.com</a></td>
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<td>Mason</td>
<td>OH</td>
<td>45404</td>
<td>513-679-6800</td>
<td>513-679-6808</td>
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<td><a href="mailto:krosssten@bfnoservices.com">krosssten@bfnoservices.com</a></td>
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<td>PO Box 298033</td>
<td>Columbus</td>
<td>OH</td>
<td>43229</td>
<td>614-405-4250</td>
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<td><a href="mailto:trudco67@gmail.com">trudco67@gmail.com</a></td>
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<td>1247 Stirmell Road</td>
<td>Columbus</td>
<td>OH</td>
<td>43223</td>
<td>614-275-4632</td>
<td>614-275-4634</td>
<td>02 - Tunneling, Boring</td>
<td>WBE SBE</td>
<td><a href="mailto:art@tunkey.net">art@tunkey.net</a></td>
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<td>Strongsville</td>
<td>OH</td>
<td>44136</td>
<td>614-744-1834</td>
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<td><a href="mailto:christine@tunkey.net">christine@tunkey.net</a></td>
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<td>45059</td>
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<td>4537 Irons Avenue</td>
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<td>216-636-1600</td>
<td>216-636-3210</td>
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<td>Upright Steel Fabricators, LLC</td>
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<td>Cleveland</td>
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<td>216-262-0852</td>
<td>216-261-9555</td>
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<td><a href="mailto:estimating@uprightsteelfab.com">estimating@uprightsteelfab.com</a></td>
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<td>US Communications and Electric, Inc.</td>
<td>4933 Neo Parkway</td>
<td>Garfield Heights</td>
<td>OH</td>
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<td>Vaughn Interior Concepts</td>
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<td>Dayton</td>
<td>OH</td>
<td>937-220-9065</td>
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<td>Powell</td>
<td>OH</td>
<td>614-437-5241</td>
<td>614-889-7988</td>
<td>01 - GC, 03 - Concrete Placement, 03 - Acco</td>
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<td>VTI Contracting</td>
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<td>317-396-7911</td>
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<td>W.C. Jones Asphalt Paving Co., Inc.</td>
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<td>5010 Linden Avenue</td>
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<td>513-662-0086</td>
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<td><a href="mailto:x615151@comcast.com">x615151@comcast.com</a></td>
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<td>Yoder Concrete Construction, LLC</td>
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<td>937-465-1500</td>
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QUALITY CONTROL MANUAL
QUALITY CONTROL MANUAL – FREQUENTLY ASKED QUESTIONS

1. Will the QC Manual be available electronically?
   Yes, it will be available on the Company Intranet. Certain checklists will be editable.

2. Who is responsible for quality on each project?
   The project team is responsible for quality. The Responsibility Matrix will be filled in by each individual project team, and the Matrix will confirm individual team member responsibilities.

3. What about smaller subs who will only be on the jobsite for a few hours to install one item? Do they need to participate in a Pre Work Meeting?
   Yes. You can meet with them for a few minutes prior to the sub starting work to review their scope specific quality control checklist.

4. Why isn’t safety mentioned in the Manual?
   Safety is covered in the previously distributed Company Safety Manual.

5. If I sign off on a quality control checklist and then there is still a problem in the future, am I accountable?
   Company employees have always been accountable for quality on the jobsites.

6. Now that we have a formal quality control program, are we taking responsibility off of our subcontractors?
   No, the Company has always been accountable for the quality of our subcontractors work.

7. Do our projects still have the standard one (1) year warranty?
   Each contract warranty period is different, and is defined in each project’s front-end documents. Beyond this specified warranty period, the statute of repose in each state we work in is different, but for instance in Ohio is 10 years. As such, Ohio owners have up to ten (10) years to seek damages from a contractor for faulty work.

8. What is a “First Work Inspection?”
   After the Pre-work Quality Control Meeting is held, and after the Subcontractor commences onsite work, an initial “First Work Inspection” shall be held. Utilize the “First Work Inspection Checklist” along with the checklist in each respective tab as a guide. Weekly quality follow-up inspections shall occur and be documented on the respective checklist that is provided in each tab of this manual.

9. Is the Company going to provide additional training on how to use this Manual?
   A hard copy of the QC manual will be provided to each project at the internal project kick-off meeting. A member of the Company Quality Control Administration Committee will attend the meeting and help roll-out the program.

10. How will the program be administered? Is the Company going to monitor the program?
    There will be internal audits performed at each jobsite. The audit process will be similar to safety audits are that are already being completed at each jobsite.

11. When will I start using this Manual?
    The Program is in effect as of January 1, 2009. All new projects that start after this date will implement the program. Also, feel free to use the QC manual as a tool for all current projects.
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### Tab 17 - Other Checklists

17-1 First Work Inspection Checklist – Use this in conjunction with the checklists provided in each section during a first work mockup inspection.

17-2 First Work Inspection Checklist Log – Use to track first work inspections.

17-3 Material Expediting Log – Use to track deliveries of major equipment and materials.

17-4 Pending QC Issue Log – Use to track all quality issues.

17-5 Above Ceiling Punchlist – Use as a guide before installation of ceiling grid.

17-7 Below Ceiling Punchlist – Use as a guide for closing out areas prior to Owner/Architect punchlists.

17-8 Concrete Placement Checklist – To be used before every concrete pour.

17-9 Daily Quality Control Report – To be used as a daily guide of quality control efforts on each project.

17-10 Exterior Skin QC & Special Inspection Checklist – To be used as a daily guide for quality inspections of the installation of exterior walls.
### QUALITY CONTROL MANUAL – TABLE OF CONTENTS (con’t)

| 17-11 | **Functional Acceptance Test** – To be used by Engineer of Record to document that the tested equipment performs per the contract specifications. |
| 17-12 | **Pipe Test Report** – To be used to document all piping pressure tests. |
| 17-13 | **Spare Parts Transfer** – To be used to document the delivery of spare parts and/or materials to the Owner. |
| 17-14 | **Certificate of Instructional Services** – To be used to document Owner acceptance of training on new equipment. |
I. EXECUTIVE SUMMARY

The Company Quality Control Program has been developed to verify that the quality model set forth in each project specification is either met or exceeded.

The key to accomplishing this is clear communication among all parties; Architects, Contractors, Engineers & Tradesmen, on each project. We will communicate “up front” in special quality control meetings, with samples and first-work construction inspections to be sure each contractor and tradesman is aware of our standards and the specification requirements. Our project staff will need to take the time to ensure these preconstruction steps are taken and then to monitor the continuing construction to verify the work is maintaining the quality of the approved sample.

II. BASIC COMPONENTS

a. Internal Kick-off Meeting

At the internal project kick-off meeting, the Project Team will complete the “Quality Control Responsibility Matrix” (see pg. 1-3) to outline the specific responsibilities for the functions outlined in both the Quality Control Manual and in the Company Operations Manual. The roles of each participant will vary depending on the type of project, contractual arrangement, and makeup of the project team; therefore, this manual does not intend to define such responsibilities. This manual does, however, serve to define the quality processes and philosophy that we will follow on all projects, regardless of size and project type.

b. Subcontractor Meetings

Quality Control will be an agenda item in every subcontractor meeting. Items to cover include a report on quality issues, arrange Pre-work Quality Control Meetings and review status of sample construction.

c. Pre-Work Meetings – Quality Control

Quality Control is an agenda item in Pre-Work Meetings as described in the Company Operations Manual. Pre-work meetings will be held with each subcontractor before their scope of work commences. See the following tabs for quality control related agenda items and checklists to review during this meeting.
d. First Work Inspections, Follow-up Inspections and Filing Process

After the Pre-work Quality Control Meeting is held and after the new work item commences, an initial “First Work Inspection” shall be held. Utilize the “First Work Inspection Checklist” (pg. 17-1) along with the checklist in each respective Tab as a guide. Weekly quality follow-up inspections shall occur and be documented on the respective checklist that is provided in each tab of this manual. Responsibility of documenting these inspections shall be determined on the Quality Control Responsibility Matrix (pg. 1-3). The Project Manager shall review the weekly follow-up reports and keep in an onsite binder – tabbed similar to this Manual.

III. SEE TABS 2-16 FOR SCOPE SPECIFIC MEETING AGENDAS & CHECKLISTS

IV. SEE TAB 17 FOR OTHER CHECKLISTS TO BE USED AS NEEDED
## QUALITY CONTROL RESPONSIBILITY MATRIX

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Ensure subcontractors and vendors are working off most current documents</td>
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<tr>
<td>Ensure proper filing &amp; distribution of submittal documents – including shop drawings, product data, samples, and test reports</td>
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<tr>
<td>Review submittals for conformance with contract documents</td>
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<tr>
<td>Ensure approved submittals are distributed to appropriate parties</td>
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<tr>
<td>Establish, maintain &amp; update project schedule to reflect submittal status and material/equip. delivery info.</td>
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<tr>
<td>Oversee construction of mock-ups to ensure quality workmanship</td>
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<tbody>
<tr>
<td>Coordinate &amp; conduct Pre-Work meetings with select subcontractors</td>
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<tr>
<td>Request &amp; obtain craft certifications as required</td>
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<tr>
<td>Invite local authorities (government, fire, etc.) in for a meeting to discuss the construction process and see if there are any special requirements.</td>
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<tbody>
<tr>
<td>Ensure all necessary testing &amp; inspections are properly performed</td>
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<tr>
<td>Coordinate testing &amp; inspection activities of Owner, Architect/Engineer, independent agencies, local authorities, or other authority having jurisdiction</td>
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<tr>
<td>Conduct or participate in off-site field inspections and tests</td>
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<tr>
<td>Coordinate establishment of initial layout points through licensed surveyor</td>
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<tr>
<td>Perform day-to-day quality walkthroughs of site to ensure compliance of contract document requirements – see Daily QC Checklist (Pg. 17-9)</td>
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<tr>
<td>Perform and document weekly quality inspections for each work activity being performed</td>
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<tr>
<td>Obtain signoff on area closures prior to concealing work</td>
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<tr>
<td>Generate quality management checklist for each task or operation as required</td>
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<tr>
<td>Witness site acceptance test to ensure compliance</td>
<td></td>
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<tr>
<td>Ensure test equipment is properly maintained and calibrated</td>
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<tr>
<td>Coordinate materials &amp; equipment deliveries – see Material Expediting Log (Pg. 17-3)</td>
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<tr>
<td>Inspect materials &amp; equipment upon delivery to ensure compliance</td>
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<tr>
<td>Ensure proper documentation is provided with delivered materials and equipment</td>
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<tr>
<td>Ensure materials and equipment are properly stored and maintained</td>
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<tbody>
<tr>
<td>Monitor and enforce subcontractor cleanup and housekeeping</td>
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<tr>
<td>Identify measures to control dust migration</td>
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<tbody>
<tr>
<td>Identify, document, track &amp; ensure repair/replacement of non-conforming work (see Pending Issues Log – Pg. 17-4)</td>
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<tr>
<td>Establish &amp; maintain quality control communication and documentation of procedures such as meetings, agendas, minutes, logs, plans, schedules, &amp; other reporting processes</td>
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<tr>
<td>Implement &amp; administer all closeout procedures including the punchlist process – see Above &amp; Below Ceiling Punchlist templates (Tab 17)</td>
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<tr>
<td>Check that as-built drawings are being updated by all contractors on a monthly basis. Turnover to Owner.</td>
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<tr>
<td>Provide turnover documents, manuals, warranties, &amp; training records for Owner at project completion</td>
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<tbody>
<tr>
<td>Create &amp; distribute all quality control reports, forms, agendas, meeting minutes &amp; other documents necessary to communicate &amp; record quality control issues</td>
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<tr>
<td>Formally respond to all Owner, Architect and/or Engineer Field Observation Reports</td>
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<tr>
<td>Provide monthly report updates identifying project quality trends &amp; critical issues</td>
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<tr>
<td>Conduct meetings with subcontractors to review the quality aspects of the project</td>
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<tbody>
<tr>
<td>Document existing conditions with video or pictures &amp; take progress photos</td>
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<tr>
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<tbody>
<tr>
<td>Sign-in sheets</td>
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</table>
DIVISION 2 - SITEWORK & DEMOLITION
PRE-WORK MEETING – QUALITY CONTROL AGENDA

PROJECT: ____________________________________________________________

Scope of Work: ___________________________ Date: _______________________

1. Review of Project Specifications
   a. Special Requirements
   b. Quality Control Tests Required

2. Review of Contract Documents
   a. Review all drawings for completeness and contractual responsibilities
   b. Review any coordination requirements from other trades

3. Review of Weekly Quality Control Checklist for the subcontractors scope of work

4. Procedure for Nonconforming Work

5. Material Storage Requirements

6. Subcontractor Responsibilities
   a. Quality Control – Primary responsibility is the subcontractors
   b. Requirement to report nonconforming work of the preceding contractor

7. Sample Construction
   a. Timing
   b. Approval Process
   c. Preservation of Approved Sample

8. Protection of Completed Work and Finishes
### WEEKLY QUALITY CONTROL CHECKLIST

**Division 2 – Sitework & Demolition**

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Survey &amp; Layout</strong></td>
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<tr>
<td>1</td>
<td>Confirm that benchmark &amp; base lines are correct – daily.</td>
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<tr>
<td>2</td>
<td>Verify that Surveyor is licensed (if required).</td>
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<tr>
<td>3</td>
<td>Plan ahead to insure all layout is protected during sitework activities.</td>
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<tr>
<td></td>
<td><strong>Site Clearing</strong></td>
<td></td>
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</tr>
<tr>
<td>1</td>
<td>Obtain all required permits - EPA, Burning, Storm Discharge, etc.</td>
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<tr>
<td>2</td>
<td>Install erosion control measures per local authorities. Check conditions as required.</td>
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<tr>
<td>3</td>
<td>Identify limits of clearing.</td>
<td></td>
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<tr>
<td>4</td>
<td>Identify structures to remain.</td>
<td></td>
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<tr>
<td>5</td>
<td>Identify trees to remain.</td>
<td></td>
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<tr>
<td>6</td>
<td>Protect trees at drip line which are to remain and which are vulnerable to damage. Protection must be in place prior to mobilization of equipment.</td>
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<tr>
<td>7</td>
<td>Are Environmental Controls in place and properly maintained (hay bales, silt fences, etc.).</td>
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<tr>
<td>8</td>
<td>Protect streams from silt contamination.</td>
<td></td>
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<tr>
<td>9</td>
<td>Check location of dump for debris.</td>
<td></td>
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</tr>
<tr>
<td>a.</td>
<td>Review Construction Documents for onsite location of hazardous materials and wastes, landfills, trash and rubbish to be removed, structures and appurtenances to remain, etc. prior to starting work.</td>
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<tr>
<td></td>
<td><strong>Sitework</strong></td>
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</tr>
<tr>
<td>1</td>
<td>Obtain necessary permits, if any.</td>
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<tr>
<td>2</td>
<td>Identify limits of work.</td>
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<tr>
<td>3</td>
<td>Compare existing topography with contract documents (especially important if contract documents are based on aerial photo topography).</td>
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<tr>
<td>4</td>
<td>As-built for all new underground construction and structures – include pictures.</td>
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<tr>
<td>5</td>
<td>Compare actual soil to boring data as soon as possible. Confirm boring location map is accurate.</td>
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<tr>
<td>6</td>
<td>Have samples of proposed backfill or imported borrow material tested for conformance with specs prior to beginning backfill work.</td>
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<tr>
<td>7</td>
<td>Retain inspector to check compaction of backfill or engineered fill. (If possible use same firm which performed soils investigations and prepared Geotechnical Report for use by Architect.)</td>
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<tr>
<td>8</td>
<td>Have pre-inspection meeting with testing inspector to review his duties.</td>
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<td>9</td>
<td>Don’t place fill on frozen ground.</td>
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<tr>
<td>10</td>
<td>Verify that all organic material is removed prior to placing new fill.</td>
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<tr>
<td>11</td>
<td>Review specs for allowable depth of fill placement (lifts).</td>
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<tr>
<td>12</td>
<td>Prior to backfilling against a retaining wall, make sure wall is braced and/or cured. Verify with structural engineer any backfill limitations.</td>
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<tr>
<td>13</td>
<td>Backfill both sides of wall - balanced fashion.</td>
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<tr>
<td>14</td>
<td>Confirm if walls are to be waterproofed. Protect during backfill.</td>
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<tr>
<td>15</td>
<td>Notify utility companies, i.e., telephone, gas, water/domestic/fire protection, electric, other; use One Call.</td>
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<tr>
<td>16</td>
<td>Locate all existing utilities; use One Call and document all calls.</td>
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<tr>
<td>17</td>
<td>Plan and locate all stockpile locations. Confirm locations will not interfere with future construction.</td>
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<tr>
<td>18</td>
<td>If site has excess topsoil, check whether local municipality has ordinance prohibiting hauling topsoil away without prior approval.</td>
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<tr>
<td>19</td>
<td>Keep topsoil stockpile neat and well drained.</td>
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<td>20</td>
<td>Document and quantify where excess soils are hauled to.</td>
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<tr>
<td>21</td>
<td>Provide temporary seeding of topsoil stockpile.</td>
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<tr>
<td>22</td>
<td>Periodic check of elevations as sitework progresses.</td>
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</table>
# WEEKLY QUALITY CONTROL CHECKLIST
## Division 2 – Sitework & Demolition (con’t)

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
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<tbody>
<tr>
<td>23</td>
<td>Keep existing roads clean and clear. Keep public roads clean.</td>
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<tr>
<td>24</td>
<td>Check bank slopes.</td>
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<tr>
<td>25</td>
<td>Barricades around all excavation.</td>
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<tr>
<td>26</td>
<td>Keep excavations drained and as dry as possible. Some municipalities require wheel wash stations and/or stone at exit.</td>
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<tr>
<td>27</td>
<td>Check base after rain and before resuming fill operations.</td>
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<tr>
<td>28</td>
<td>Visually inspect cut and fill areas for pumping and/or rolling prior to backfilling of additional fill. Observe ground behavior under equipment or truck load. If it “pumps” or “weaves”, problems exist.</td>
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<tr>
<td>29</td>
<td>Maintain temporary soil erosion and storm water management systems required during construction.</td>
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<tr>
<td>30</td>
<td>Establish site access/egress, truck wash, parking, staging, etc.</td>
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### Demolition

| 1   | Obtain required permits, if any.                                      |                     |                      |
| 2   | Notify utility companies, i.e., telephone, gas, water/domestic/fire protection, electric, other; use One Call. |                     |                      |
| 3   | Check rubbish chute (if required) for proper support.                |                     |                      |
| 4   | Establish a good working plan; review with the Subcontractor.       |                     |                      |
| 5   | Verify that existing floors will support demolition equipment.      |                     |                      |
| 6   | Check structural requirements prior to cutting openings.             |                     |                      |
| 7   | If the fire protection sprinkler system is to be shut down, notify Owner and his insurance underwriter and supplement with fire watch or fire department standby. |                     |                      |
| 8   | Assure adequate lighting.                                           |                     |                      |
| 9   | Post signs indicating passageways, stairways and demolition area.   |                     |                      |
| 10  | Install necessary barricades.                                       |                     |                      |
| 11  | Have water available for dust control.                              |                     |                      |
| 12  | Agree on salvage items with Owner; establish a program for Owner notification and removal. |                     |                      |
| 13  | Follow all safety guidelines.                                       |                     |                      |
| 14  | Check for hazardous material or residue in existing pipes and ducts. This is critical in laboratory and hospital conditions. |                     |                      |
| 15  | Verify that all utilities are disconnected prior to demolition & are disconnected at proper location. |                     |                      |

### Blasting

| 1   | Obtain required permits, if any.                                      |                     |                      |
| 2   | Special insurance is required.                                        |                     |                      |
| 3   | Use only licensed personnel.                                          |                     |                      |
| 4   | Fire protection available.                                            |                     |                      |
| 5   | Post signs - “No radio transmission”.                                 |                     |                      |
| 6   | Erect necessary barricades.                                          |                     |                      |
| 7   | Store explosives in an authorized container area. If possible, deliver explosives as needed. |                     |                      |
| 8   | Notify local police to guard against theft of explosives.            |                     |                      |
| 9   | If necessary, use seismic equipment to monitor blastings.            |                     |                      |
| 10  | Inspect existing structures prior to blasting, including neighbors.  |                     |                      |
| 11  | Take photographs (video preferred) of existing structures before and after blasting, including neighbors. |                     |                      |
| 12  | Protection - heavy mats/other.                                       |                     |                      |
| 13  | Keep daily work logs (quantity of explosives, result of blast).     |                     |                      |
## WEEKLY QUALITY CONTROL CHECKLIST

**Division 2 – Sitework & Demolition (con’t)**

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<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
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<tbody>
<tr>
<td><strong>Pilings</strong></td>
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<tr>
<td>1</td>
<td>Pilings</td>
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<td>2</td>
<td>Retain independent inspection agency full time on jobsite.</td>
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<tr>
<td>3</td>
<td>Review type of pile furnished for conformance with approved data; review boring logs and subsurface reports for anticipated obstructions and driving depths.</td>
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<tr>
<td>4</td>
<td>Verify location of piles before and after drilling.</td>
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<td>5</td>
<td>Orientation of special piling.</td>
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<td>6</td>
<td>Hammer adequacy - check ft.-lbs. energy data.</td>
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<td>7</td>
<td>Test piles if required.</td>
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<td>8</td>
<td>Monitor any vibration from pile installation.</td>
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<tr>
<td>9</td>
<td>Monitor driving of piles according to formula for adequate load. Blows per inch.</td>
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<tr>
<td>10</td>
<td>Load test - check BOCA method and insure approval by authorities.</td>
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<tr>
<td>11</td>
<td>Keep as-buils record of the depth of piles.</td>
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<tr>
<td>12</td>
<td>Wood piles - check diameter, length, driving shoes, preservative certification and timber certification.</td>
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<tr>
<td>13</td>
<td>Wood piles - cut off end of wood piles, preservative treat exposed butt.</td>
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<tr>
<td>14</td>
<td>For hollow piles to be concrete filled, check pile before filling to ensure: shell has not collapsed, interior is clean and is free of mud and water.</td>
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<tr>
<td>15</td>
<td>For cast-in-place piles, check that the reinforcing cage is in its proper location.</td>
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<tr>
<td>16</td>
<td>If working near existing buildings, document existing conditions.</td>
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<tr>
<td><strong>Landsaping</strong></td>
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<tr>
<td>1</td>
<td>Avoid contamination of topsoil with subsoil during topsoil stockpiling operations.</td>
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<tr>
<td>2</td>
<td>Spread topsoil evenly to the correct depth.</td>
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<tr>
<td>3</td>
<td>Check grade elevations to ensure proper drainage of surface water.</td>
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<tr>
<td>4</td>
<td>Check for removal of stones and other objects prior to seeding or sodding.</td>
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<tr>
<td>5</td>
<td>Check seed mixture versus specification requirements.</td>
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<tr>
<td>6</td>
<td>Protect seeding (hydroseed or straw mulch).</td>
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<tr>
<td>7</td>
<td>Inspect the moisture conditions of sod.</td>
<td></td>
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<tr>
<td>8</td>
<td>Plant only within approved seasons.</td>
<td></td>
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<tr>
<td>9</td>
<td>Check foliage for wilt or dryness.</td>
<td></td>
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<tr>
<td>10</td>
<td>Check dimensions of tree and plant ball.</td>
<td></td>
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<tr>
<td>11</td>
<td>Reject plants with balls broken, cracked or pliable.</td>
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<tr>
<td>12</td>
<td>For bare root plants, obtain certification that plants were dug when fully dormant.</td>
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<tr>
<td>13</td>
<td>Check for broken roots.</td>
<td></td>
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<tr>
<td>14</td>
<td>Review method of handling during transit.</td>
<td></td>
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<tr>
<td>15</td>
<td>Check depth, diameter and spacing of excavation.</td>
<td></td>
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<tr>
<td>16</td>
<td>Review watering schedule and responsibility.</td>
<td></td>
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<tr>
<td>17</td>
<td>Most common cause of plant or tree death is “drowning”. Be sure design provides for adequate drainage at root level if soil is not naturally porous.</td>
<td></td>
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<tr>
<td><strong>Bituminous Paving</strong></td>
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</tr>
<tr>
<td>1</td>
<td>Design mix to be approved by Architect or engineer.</td>
<td></td>
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</tr>
<tr>
<td>2</td>
<td>Take periodic samples of batch from trucks and have tested by testing agency. Compare results with design requirements – including temperature.</td>
<td></td>
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<tr>
<td>3</td>
<td>Have testing agency check batch plants periodically, if required.</td>
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<tr>
<td>4</td>
<td>Verify depth of each paving layer (lift).</td>
<td></td>
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<tr>
<td>5</td>
<td>Take cores for sample testing. Maintain sample records.</td>
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<tr>
<td>6</td>
<td>Ensure adequacy of tack coat (gallons/sy).</td>
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<tr>
<td>7</td>
<td>Make sure subgrade is suitable to receive paving; excavate pumping and rolling areas if required.</td>
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<tr>
<td>8</td>
<td>The subgrade elevation (by others) to be checked. See specs for tolerances.</td>
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<tr>
<td>9</td>
<td>Discuss protection of curbs (chipping, staining) with roller operators prior to starting paving operation.</td>
<td></td>
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<tr>
<td>10</td>
<td>Check castings for damage from equipment (manholes, gratings, etc.).</td>
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</tbody>
</table>
DIVISION 3 - CONCRETE
PRE-WORK MEETING – QUALITY CONTROL AGENDA

PROJECT: 

Scope of Work: ___________________________ Date: ___________________________

1. Review of Project Specifications
   a. Special Requirements
   b. Quality Control Tests Required

2. Review of Contract Documents
   a. Review Drawings for Completeness and Contractual Responsibilities
   b. Review Coordination Requirements from Other Trades

3. Review of Weekly Quality Control Checklist for the subcontractors scope of work

4. Procedure for Nonconforming Work

5. Material Storage Requirements

6. Subcontractor Responsibilities
   a. Quality Control – Primary responsibility is the subcontractors
   b. Requirement to report nonconforming work of the preceding contractor

7. Sample Construction
   a. Timing
   b. Approval Process
   c. Preservation of Approved Sample

8. Protection of Completed Work and Finishes
<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Concrete Forming</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Verify that footing excavation bottoms are solid.</td>
<td></td>
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<tr>
<td>2</td>
<td>Pour schedule preparation.</td>
<td></td>
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<tr>
<td>3</td>
<td>Check tie designs and spacing if concrete is to be exposed.</td>
<td></td>
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<tr>
<td>4</td>
<td>Check all keyway requirements.</td>
<td></td>
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<tr>
<td>5</td>
<td>Check location (layout) of forms.</td>
<td></td>
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<tr>
<td>6</td>
<td>Check form supports for conformance with form drawings and basic soundness.</td>
<td></td>
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<tr>
<td>7</td>
<td>Check forms for plumb.</td>
<td></td>
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<tr>
<td>8</td>
<td>Check interior condition of forms for soundness and proper surface finish.</td>
<td></td>
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<tr>
<td>9</td>
<td>Clean out area prior to pour.</td>
<td></td>
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<tr>
<td>10</td>
<td>Check installation and number of form ties.</td>
<td></td>
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<tr>
<td>11</td>
<td>Oil metal forms.</td>
<td></td>
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<tr>
<td>12</td>
<td>Wet down forms prior to pour.</td>
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<td></td>
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<tr>
<td>13</td>
<td>Form supports must not be stripped prematurely. Check specifications for any surface applied curing materials.</td>
<td></td>
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</tr>
<tr>
<td>14</td>
<td>Check location and size of sleeves.</td>
<td></td>
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<tr>
<td>15</td>
<td>Check for inverts and box outs.</td>
<td></td>
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<tr>
<td>16</td>
<td>Sleeves in exterior walls should be non-ferrous (avoid rust stains).</td>
<td></td>
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</tr>
<tr>
<td></td>
<td><strong>Reinforcing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Place reinforcing in accordance with rebar shop drawings.</td>
<td></td>
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<tr>
<td>2</td>
<td>Support reinforcing with proper accessories.</td>
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<tr>
<td>3</td>
<td>Reinforcing to be free of mud and dirt. Store rebar off of ground surface.</td>
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<tr>
<td>4</td>
<td>Keep reinforcing at least 3&quot; from bottom of footing or as indicated on drawings.</td>
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<tr>
<td>5</td>
<td>Check rebar coverage for beams, girders and columns.</td>
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<tr>
<td>6</td>
<td>Check number, size and configuration of rebar prior to pour.</td>
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<tr>
<td>7</td>
<td>Check mill mark for Grade Type (E60), etc.</td>
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<tr>
<td>8</td>
<td>Set up a foolproof system to ensure that the proper grade rebar is placed in the correct location.</td>
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<tr>
<td>9</td>
<td>Reinforcing mesh in slabs per specifications.</td>
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<tr>
<td></td>
<td><strong>Cast-in-Place Concrete</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Familiarize labor and finisher foreman with mix design, especially super plasticizer. Review restrictions on adding water to concrete at site.</td>
<td></td>
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<tr>
<td>2</td>
<td>Review approved design mixes for all strengths.</td>
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<tr>
<td>3</td>
<td>Create batch card that is an easy resource to confirm mix design for each concrete activity.</td>
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<tr>
<td>4</td>
<td>Check truck time from start of mixing of concrete. You don’t want the initial set of concrete to begin in the truck.</td>
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<tr>
<td>5</td>
<td>Check specifications for cylinder break requirements.</td>
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<tr>
<td>6</td>
<td>Take slump tests.</td>
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<td>7</td>
<td>Check placement procedures.</td>
<td></td>
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<tr>
<td>8</td>
<td>Don’t over-vibrate concrete.</td>
<td></td>
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<tr>
<td>9</td>
<td>If high or low temperature extremes are likely, make prior arrangements for cooling or heating concrete.</td>
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<tr>
<td>10</td>
<td>Ensure wire mesh reinforcing is placed and maintained in the design location. Wire mesh should have proper support during placement.</td>
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<tr>
<td>11</td>
<td>Arrange for temporary lighting if pouring and finishing is required after daylight hours.</td>
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<tr>
<td>12</td>
<td>Don’t allow surfaces of slabs to dry too quickly. Ensure curing is controlled. An excellent cure for slabs is water (moist curing).</td>
<td></td>
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</tr>
<tr>
<td>13</td>
<td>Arrange to saw cut slabs on grade as soon as possible after pour to avoid cracking.</td>
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<td></td>
</tr>
</tbody>
</table>
### WEEKLY QUALITY CONTROL CHECKLIST

**Division 3 – Concrete (con’t)**

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Monitor curing compound - make sure material used is compatible with tile, terrazzo and other finishes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Ensure that screeds for floor slabs and decks are set at the proper elevation prior to the concrete pour.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>During concrete floor pours, continually check elevation to ensure a flat surface. Fully understand elevated slab engineering requirements since deflection will occur, understand tolerances &amp; review with foreman. Check grades prior to placing concrete.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Keep cured concrete clean and free from debris that may cause rust staining.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Architectural Precast Concrete

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Keep approved samples in field office.</td>
</tr>
<tr>
<td>2</td>
<td>Check for proper placements of inserts.</td>
</tr>
<tr>
<td>3</td>
<td>Coordinate clips and brackets with structural steel fabricators and precaster.</td>
</tr>
<tr>
<td>4</td>
<td>Coordinate all embedment between precast and other trades.</td>
</tr>
<tr>
<td>5</td>
<td>Review horizontal and vertical alignment tolerances allowed for the precast elements. Check to be sure you obtain these tolerances.</td>
</tr>
<tr>
<td>6</td>
<td>Visit plant periodically to ensure specifications are being followed.</td>
</tr>
<tr>
<td>7</td>
<td>Arrange to obtain copies of precaster’s concrete cylinder tests.</td>
</tr>
<tr>
<td>8</td>
<td>Check for proper dimension of forms and openings.</td>
</tr>
<tr>
<td>9</td>
<td>Check for proper reinforcing.</td>
</tr>
<tr>
<td>10</td>
<td>Compare approved sample with new panels. Color, texture, etc.</td>
</tr>
<tr>
<td>11</td>
<td>Determine sequence of installation for steel, spray fireproofing and precast.</td>
</tr>
<tr>
<td>12</td>
<td>Keep precast on dunnage during storage. Ensure that dunnage does not stain precast.</td>
</tr>
<tr>
<td>13</td>
<td>Make sure lifting cables and slings are in first class condition.</td>
</tr>
<tr>
<td>14</td>
<td>Be sure erection shims &amp; wedges are permanent and non-corrosive.</td>
</tr>
<tr>
<td>15</td>
<td>Mounting and adjusting nuts and bolts should be permanently anchored in place following final alignment. (Usually by tack welding)</td>
</tr>
<tr>
<td>16</td>
<td>Patch all holes and depressions in precast used for lifting and handling.</td>
</tr>
<tr>
<td>17</td>
<td>Insure qualified craftsman performs cosmetic patching and repair on exposed faces of precast.</td>
</tr>
<tr>
<td>18</td>
<td>Exposed surfaces of precast must be free of all dirt stains and cracking from transportation and handling. Document any and all deficiencies immediately.</td>
</tr>
<tr>
<td>19</td>
<td>Check requirements for required inserts or embeds.</td>
</tr>
</tbody>
</table>

#### Structural Precast Concrete

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Be sure shop drawings include all required inserts and embedments.</td>
</tr>
<tr>
<td>2</td>
<td>Obtain and retain approved sample of the precast to serve as a standard of the agreed finish and workmanship.</td>
</tr>
<tr>
<td>3</td>
<td>Check bearing pads at support points for conformity with contract requirements.</td>
</tr>
<tr>
<td>4</td>
<td>Patch concrete at lifting points and lifting inserts.</td>
</tr>
<tr>
<td>5</td>
<td>Cosmetic patch at exposed surfaces (honeycomb, chips, erection damage, etc.)</td>
</tr>
<tr>
<td>6</td>
<td>Visit plant periodically to ensure finish product is in accordance with approved sample.</td>
</tr>
</tbody>
</table>
DIVISION - 4 MASONRY
PRE-WORK MEETING – QUALITY CONTROL AGENDA

PROJECT: ________________________________

Scope of Work: _______________________ Date: __________________

1. Review of Project Specifications
   a. Special Requirements
   b. Quality Control Tests Required

2. Review of Contract Documents
   a. Review all drawings for completeness and contractual responsibilities
   b. Review any coordination requirements from other trades

3. Review of Weekly Quality Control Checklist for the subcontractors scope of work

4. Procedure for Nonconforming Work

5. Material Storage Requirements

6. Subcontractor Responsibilities
   a. Quality Control – Primary responsibility is the subcontractors
   b. Requirement to report nonconforming work of the preceding contractor

7. Sample Construction
   a. Timing
   b. Approval Process
   c. Preservation of Approved Sample

8. Protection of Completed Work and Finishes
## WEEKLY QUALITY CONTROL CHECKLIST
### Division 4 – Masonry

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
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</thead>
<tbody>
<tr>
<td></td>
<td><strong>Masonry</strong></td>
<td></td>
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</tr>
<tr>
<td>1</td>
<td>Prior to installation, have a separate flashing installation meeting to go over what type and how flashings are to be installed. Discuss materials, drip edging, projections of flashing or cut off flush. Then inspect at each level of flashing as it is installed for proper installation, termbars, mastic, etc. If there are any doubts, flood the cavity with a hose and check for leaks prior to going up with the veneer.</td>
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<tr>
<td>2</td>
<td>Prior to starting masonry, ensure that expansion and control joint filler material is in accordance with approved samples. Verify expansion/control joint requirements. If not on drawings, ask architect to provide exact locations.</td>
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<tr>
<td>3</td>
<td>All masonry samples are to be approved by the Architect.</td>
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<tr>
<td>4</td>
<td>Approved samples to be stored in field office for comparison to material delivered.</td>
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<tr>
<td>5</td>
<td>Prepare mock up panels when required and have approved by Architect and/or Owner. Keep on site during the masonry operation as a sample panel may become a legal document after it is approved and may be necessary for review if a problem arises.</td>
<td></td>
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<tr>
<td>6</td>
<td>Examine representative pallets of concrete masonry units when delivered to the jobsite. Check for significant quantities of block with chips, broken corners and voids. Notify manufacturer of excessive damage.</td>
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<td></td>
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<tr>
<td>7</td>
<td>Inspect materials immediately after installation for quality workmanship standards and noticeable color changes. Check for proper jointing tools and of the proper type profile along with acceptable joint alignment.</td>
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<tr>
<td>8</td>
<td>Store material off ground and keep covered.</td>
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<tr>
<td>9</td>
<td>Check for proper reinforcing. Type size and location. Also check for proper length per the approved drawings or design criteria and do not rely upon the testing agency for verification.</td>
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<tr>
<td>10</td>
<td>Check mortar mix for conformance with design mix and proper color.</td>
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<tr>
<td>11</td>
<td>Check wall anchors for proper material (galvanized, stainless steel, etc.)</td>
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<tr>
<td>12</td>
<td>Check wall anchors or other embedments for proper location and spacing.</td>
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<tr>
<td>13</td>
<td>Where backfill occurs on one side, unless reinforced, never backfill without consulting Structural Engineer. Do not allow operation to begin until wall is properly supported.</td>
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<tr>
<td>14</td>
<td>Check openings. Maintain coursing through openings.</td>
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<tr>
<td>15</td>
<td>Check location and proper overlap of thru-wall flashings.</td>
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<tr>
<td>16</td>
<td>Check type and location of weep holes and wall vents.</td>
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<tr>
<td>17</td>
<td>Ensure that mortar joints are level, plumb and proper thickness.</td>
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<tr>
<td>18</td>
<td>Ensure that tooled joints are proper type (concave, convex or flush)</td>
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<tr>
<td>19</td>
<td>Cover top of walls each night.</td>
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<tr>
<td>20</td>
<td>Do not permit masons to slush excess mortar into the cavity space of a two-wythe wall. That will seriously impair functioning of the weep holes.</td>
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<tr>
<td>21</td>
<td>Conduct periodic Quality Control meetings with masonry sub</td>
<td></td>
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<tr>
<td>22</td>
<td>Check location, size and type of all sleeves.</td>
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<tr>
<td>23</td>
<td>Check type of lintels required.</td>
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<tr>
<td>24</td>
<td>Review specifications for Final Cleaning Brick &amp; Block.</td>
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<tr>
<td>25</td>
<td>Review requirements for final acceptance. Does scaffold need left up for architect review?</td>
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<tr>
<td>26</td>
<td>Review the Company’s Water Intrusion Management Plan.</td>
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</tbody>
</table>
DIVISION – 5 METALS
PRE-WORK MEETING – QUALITY CONTROL AGENDA

PROJECT: ________________________________________________________________

Scope of Work: ________________________ Date: ______________________

1. Review of Project Specifications
   a. Special Requirements
   b. Quality Control Tests Required

2. Review of Contract Documents
   a. Review all drawings for completeness and contractual responsibilities
   b. Review any coordination requirements from other trades

3. Review of Weekly Quality Control Checklist for the subcontractors scope of work

4. Procedure for Nonconforming Work

5. Material Storage Requirements

6. Subcontractor Responsibilities
   a. Quality Control – Primary responsibility is the subcontractors
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7. Sample Construction
   a. Timing
   b. Approval Process
   c. Preservation of Approved Sample

8. Protection of Completed Work and Finishes
### WEEKLY QUALITY CONTROL CHECKLIST
Division 5 – Metals

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Structural Steel</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Plant visitations.</td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td>Mill certificates.</td>
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<td></td>
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<tr>
<td>3</td>
<td>If specifications call for approval of shop or field welding procedures, be sure the fabricator or erector submits them.</td>
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<tr>
<td>4</td>
<td>If specifications require qualified welders in the shop or in the field, examine the papers of the persons proposed to be sure their qualifications are current and cover the type welding required for the project.</td>
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<tr>
<td>5</td>
<td>Check that bolts used are in accordance with specifications. Especially important for high strength bolts.</td>
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<tr>
<td>6</td>
<td>Check the bolt and nut containers in the field to be certain the specified fasteners are used.</td>
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<tr>
<td>7</td>
<td>Check shop painting for approved colors and coverage.</td>
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<tr>
<td>8</td>
<td>Coordinate painting or non-painting of steel with spray fireproofing.</td>
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<tr>
<td>9</td>
<td>Verify welds for location, size, etc. per document specification.</td>
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<tr>
<td>10</td>
<td>Testing results of X-rays, etc. to be kept on file.</td>
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<tr>
<td>11</td>
<td>Check calibration of testing equipment.</td>
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<tr>
<td>12</td>
<td>Check alignment of all members.</td>
<td></td>
<td></td>
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<tr>
<td>13</td>
<td>Employ an independent inspection agency to examine the structural steel structure to include, but not be limited to, the following:</td>
<td></td>
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<tr>
<td></td>
<td>• plumbness</td>
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<tr>
<td></td>
<td>• bolts torqued to proper design</td>
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<tr>
<td></td>
<td>• type of bolts used are as specified</td>
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<tr>
<td></td>
<td>• welds are as specified</td>
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<tr>
<td></td>
<td>• steel members are correct size and length</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>• moment connections are correct</td>
<td></td>
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</tr>
<tr>
<td>14</td>
<td>Never allow holes or cutouts to be burned in rolled shapes in the field without first reviewing with the Structural Engineer.</td>
<td></td>
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<tr>
<td>15</td>
<td>Check leveling plates for perfect level and flatness before steel columns are set on the plates.</td>
<td></td>
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<tr>
<td>16</td>
<td>Perimeter safety cable may be required of steel subcontractor. Cable will need to be installed prior to and after concrete slab placement. Ensure coordination as well as where material/equipment mobilization points will be located so cable installation is not affected.</td>
<td></td>
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<tr>
<td>17</td>
<td>All field modifications must be approved by Engineer.</td>
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<tr>
<td>18</td>
<td>Confirm domestic requirements for all steel, including bolts and fasteners.</td>
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<td></td>
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<tr>
<td>19</td>
<td>Field painting of all welds and damage if required.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td><strong>Open Web Steel Joists</strong></td>
<td></td>
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</tr>
<tr>
<td>1</td>
<td>Make certain proper quantity of end fasteners are used when joining joists to other building elements.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Check for proper type and quantity of bridging between joists.</td>
<td></td>
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</tr>
<tr>
<td>3</td>
<td>Be sure lower chord extensions, when required, are properly secured to the intended adjacent construction.</td>
<td></td>
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</tr>
<tr>
<td>4</td>
<td>When other trades begin to support equipment from steel joists, they must support only from panel points, if they choose to hang from the lower chord.</td>
<td></td>
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</tr>
<tr>
<td>5</td>
<td>Verify end conditions with bearing or connection conditions.</td>
<td></td>
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<tr>
<td>6</td>
<td>Verify root joists are designed for snow loads.</td>
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<tr>
<td></td>
<td><strong>Metal Deck</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Check gauge, configuration and finish of deck upon delivery to jobsite. (galvanized, painted, phos-painted)</td>
<td></td>
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</tr>
<tr>
<td>2</td>
<td>If deck is to remain exposed, make sure it is handled and stored properly.</td>
<td></td>
<td></td>
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<tr>
<td>3</td>
<td>If composite deck, check shear stud location and welds.</td>
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<tr>
<td>4</td>
<td>Shear studs must be physically tested (beaten with sledge hammer).</td>
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<tr>
<td>5</td>
<td>Check sump pan locations.</td>
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<tr>
<td>No.</td>
<td>Item</td>
<td>Sub Initials &amp; Date</td>
<td>G.C. Initials &amp; Date</td>
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<td>-----</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>6</td>
<td>Check spacing and size of puddle welds used to fasten deck to steel structure. Review if washers are required for this welding operation at roof decking.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Check both floor and roof deck for proper type and spacing of side lap fastening.</td>
<td></td>
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</tr>
<tr>
<td>8</td>
<td>Require tough up of puddle welds on roof deck before applying insulation and membrane roofing.</td>
<td></td>
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</tr>
<tr>
<td>9</td>
<td>Clean metal deck prior to pour.</td>
<td></td>
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<tr>
<td>10</td>
<td>Coordinate cleanliness (removal of oils) with any spray fireproofing or painting operations.</td>
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<tr>
<td>11</td>
<td>Determine if temporary support is required for construction loading or concrete placement.</td>
<td></td>
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<tr>
<td>12</td>
<td>Review penetrations and attachments with other trades.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Confirm if mechanically fastening deck is acceptable.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Miscellaneous Metal**

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Round pipe railings, where joined, must be neatly welded and carefully ground to provide a smooth and continuous profile.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Steel members to be in permanent contact with masonry generally must be treated with a bitumastic coating on the sides or faces to be in contact with the masonry.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>When welding miscellaneous metal in semi-finished spaces, (i.e. toilet rooms), protect the existing finished surfaces from burning or scarring from weld spatter.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Check for proper galvanizing on miscellaneous metal, where required.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Check that proper stainless steel anchors are being used below the water level in Tanks.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DIVISION 6 – CARPENTRY
PRE-WORK MEETING – QUALITY CONTROL AGENDA

PROJECT: ________________________________________________

Scope of Work: ________________________________ Date: ____________________

1. Review of Project Specifications
   a. Special Requirements
   b. Quality Control Tests Required

2. Review of Contract Documents
   a. Review all drawings for completeness and contractual responsibilities
   b. Review any coordination requirements from other trades

3. Review of Weekly Quality Control Checklist for the subcontractors scope of work

4. Procedure for Nonconforming Work

5. Material Storage Requirements

6. Subcontractor Responsibilities
   a. Quality Control – Primary responsibility is the subcontractors
   b. Requirement to report nonconforming work of the preceding contractor

7. Sample Construction
   a. Timing
   b. Approval Process
   c. Preservation of Approved Sample

8. Protection of Completed Work and Finishes
### WEEKLY QUALITY CONTROL CHECKLIST
#### Division 6 – Carpentry

<table>
<thead>
<tr>
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<th>G.C. Initials &amp; Date</th>
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<tbody>
<tr>
<td></td>
<td><strong>Rough Carpentry</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Check wood species, hemlock, fir, pine, etc.</td>
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<tr>
<td>2</td>
<td>Be sure wood meets dimensional requirements and is stamped with proper grade mark.</td>
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</tr>
<tr>
<td>3</td>
<td>Check drawings for wood blocking requirements.</td>
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<tr>
<td>4</td>
<td>Certification of wood preservative treatment.</td>
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<tr>
<td>5</td>
<td>Certification of fire treatment.</td>
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<tr>
<td>6</td>
<td>Affidavits from lumber supplier for moisture content.</td>
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<tr>
<td>7</td>
<td>Stack on site with proper ventilation and protection.</td>
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<tr>
<td>8</td>
<td>Proper quality - straight, true, flat, etc.</td>
<td></td>
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</tr>
<tr>
<td>9</td>
<td>Confirm code requirements for fire treatment versus wood preservative treatment.</td>
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<tr>
<td>10</td>
<td>Proper fasteners for use.</td>
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<tr>
<td>11</td>
<td>Proper glue for intended use (if applicable - interior/exterior).</td>
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<tr>
<td>12</td>
<td>Proper width/thickness for use. Review heights and clearances required for skylights.</td>
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<tr>
<td>13</td>
<td>Allowance for shimming, if required.</td>
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<tr>
<td></td>
<td><strong>Finish Carpentry</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Review hardware and built-in requirements.</td>
<td></td>
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<tr>
<td>2</td>
<td>Coordinate opening dimensions with wall construction and millwork fabrication.</td>
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<tr>
<td>3</td>
<td>Verify that blocking and backing is as required.</td>
<td></td>
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</tr>
<tr>
<td>4</td>
<td>Receive, unload, handle, store and distribute millwork, doors, hardware, etc.</td>
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<tr>
<td></td>
<td><strong>Millwork</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>All hardware as specified.</td>
<td></td>
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<tr>
<td>2</td>
<td>No bubbles or failure in plastic laminate.</td>
<td></td>
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<tr>
<td>3</td>
<td>Interiors to have finish or backer laminate as required.</td>
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<tr>
<td>4</td>
<td>Doors and drawers function properly.</td>
<td></td>
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<tr>
<td>5</td>
<td>Colors match approved samples.</td>
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<tr>
<td>6</td>
<td>Cut-outs for work by others in proper locations and to proper dimensions.</td>
<td></td>
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</tr>
<tr>
<td>7</td>
<td>Check for construction methods as fabricated units are delivered to jobsite.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DIVISION 7 - THERMAL & MOISTURE PROTECTION
PRE-WORK MEETING – QUALITY CONTROL AGENDA

PROJECT: ____________________________________________

Scope of Work: ___________________________ Date: ________________

1. Review of Project Specifications
   a. Special Requirements
   b. Quality Control Tests Required

2. Review of Contract Documents
   a. Review all drawings for completeness and contractual responsibilities
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4. Procedure for Nonconforming Work

5. Material Storage Requirements

6. Subcontractor Responsibilities
   a. Quality Control – Primary responsibility is the subcontractors
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7. Sample Construction
   a. Timing
   b. Approval Process
   c. Preservation of Approved Sample

8. Protection of Completed Work and Finishes
## WEEKLY QUALITY CONTROL CHECKLIST
### Division 7 – Thermal & Moisture Protection

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Waterproofing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Compare material delivered with approved samples</td>
<td></td>
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<tr>
<td>2</td>
<td>Review plans and specs as to requirements</td>
<td></td>
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</tr>
<tr>
<td>3</td>
<td>Surface to be clean and free of foreign material, also dry</td>
<td></td>
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<tr>
<td>4</td>
<td>Check for proper curing of substrates, especially concrete walls. Check time restraints.</td>
<td></td>
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<tr>
<td>5</td>
<td>Check temperature - usually should be 40 degrees Fahrenheit and rising</td>
<td></td>
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<tr>
<td>6</td>
<td>If bituminous saturated felts are used, make sure plies are (a) overlapped, (b) common joint does not occur, (c) coating checked for breaks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>If backfill is required, ensure there is no debris, rocks, etc. used that may damage the plies</td>
<td></td>
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<tr>
<td>8</td>
<td>If mixture of material is required, make sure mixture is prepared properly</td>
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<tr>
<td>9</td>
<td>Review manufacturer’s recommendations.</td>
<td></td>
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<tr>
<td>10</td>
<td>Check concrete finish requirements. Do holes need patched? Walls rubbed?</td>
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<tr>
<td></td>
<td><strong>Building Insulation</strong></td>
<td></td>
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</tr>
<tr>
<td>1</td>
<td>Compare samples of approved material</td>
<td></td>
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<tr>
<td>2</td>
<td>Check that insulation is installed correctly &amp; that it fits properly</td>
<td></td>
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<tr>
<td>3</td>
<td>Check method of attachment including use of pins and adhesives</td>
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<tr>
<td>4</td>
<td>Check if thickness is correct</td>
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<tr>
<td>5</td>
<td>Make sure material is stored properly; off the ground, covered &amp; dry</td>
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<tr>
<td>6</td>
<td>Make sure the foil or other vapor barrier side is installed correctly (generally facing inward)</td>
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<tr>
<td>7</td>
<td>Use of Kraft paper may not meet flame spread requirements. Review material used with specification</td>
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<tr>
<td>8</td>
<td>Confirm that “R” value and type meets contract requirements</td>
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<tr>
<td>9</td>
<td>Watch for moisture issues with sprayed insulations.</td>
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<tr>
<td>10</td>
<td>Check that design does not create a “double vapor barrier.”</td>
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<tr>
<td></td>
<td><strong>Metal Siding</strong></td>
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<tr>
<td>1</td>
<td>Request assurance that subsurface is prepared and aligned properly</td>
<td></td>
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</tr>
<tr>
<td>2</td>
<td>Check gauge/thickness of material</td>
<td></td>
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</tr>
<tr>
<td>3</td>
<td>Check profile of siding</td>
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<td></td>
</tr>
<tr>
<td>4</td>
<td>Check color</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Check texture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Check flashing and accessories to be used in conjunction with siding</td>
<td></td>
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</tr>
<tr>
<td>7</td>
<td>Compare color of accessories and siding for compatibility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Check fastening requirements</td>
<td></td>
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<tr>
<td>9</td>
<td>Ensure that all connection clips are corrosion resistant</td>
<td></td>
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<tr>
<td>10</td>
<td>Separate aluminum siding from carbon steel support structure by a “dielectric insulator”</td>
<td></td>
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<tr>
<td>11</td>
<td>Pay attention to the detailing and installation of corners, copings, penetrations and junctions with adjacent surfaces</td>
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<tr>
<td>12</td>
<td>Touch-up cut ends of metal siding.</td>
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<tr>
<td></td>
<td><strong>Membrane Roofing</strong></td>
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<tr>
<td>1</td>
<td>Check Owner’s insurance company requirements versus contract documents</td>
<td></td>
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<tr>
<td>2</td>
<td>Make sure surface is clean and dry</td>
<td></td>
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<tr>
<td>3</td>
<td>If vapor barrier is required, compare specification with material delivered</td>
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<tr>
<td>4</td>
<td>Make sure vapor barrier provides a complete seal</td>
<td></td>
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</tr>
<tr>
<td>5</td>
<td>Check temperature requirements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Insulation is to be kept dry during storage. If roof installation is phased, make sure stop and start joints are projected from the weather</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Compare insulation delivered with material approved by Architect</td>
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</tbody>
</table>
### WEEKLY QUALITY CONTROL CHECKLIST
**Division 7 – Thermal & Moisture Protection (con’t)**

<table>
<thead>
<tr>
<th>No.</th>
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<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Check if F.M. requires mechanical fastening of insulation a certain distance in from edge of roof</td>
<td></td>
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<tr>
<td>9</td>
<td>Stagger insulation joints</td>
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<tr>
<td>10</td>
<td>Make sure roof drains are protected and are in working condition before beginning roofing installation</td>
<td></td>
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</tr>
<tr>
<td>11</td>
<td>All vents, equipment curbs, wood nailers, etc. should be in place prior to beginning roof installation. Verify blocking &amp; insulation details – review roofing manufacturing requirement.</td>
<td></td>
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</tr>
<tr>
<td>12</td>
<td>Review all temperature requirements</td>
<td></td>
<td></td>
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<tr>
<td>13</td>
<td>Check the color and size of aggregate required. Compare with approved sample</td>
<td></td>
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</tr>
<tr>
<td>14</td>
<td>Make sure excessive roof loading does not occur. May need temporary wood runways</td>
<td></td>
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<tr>
<td>15</td>
<td>Fire extinguishers must be located at the “kettle” and on roof level – size per OSHA requirements.</td>
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<tr>
<td>16</td>
<td>Review requirements for maximum asphalt temperature and spot check the kettle thermometer periodically. A 1-hour fire watch per NFPA51B is required.</td>
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<tr>
<td>17</td>
<td>Review specifications for inspection requirements – document inspections</td>
<td></td>
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<tr>
<td>18</td>
<td>Check fire rating requirements. Is dense glass required?</td>
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</table>

#### Single Membrane Roofing

<table>
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<tbody>
<tr>
<td>1</td>
<td>Subcontractor must be an approved installer of the roofing manufacturer’s product</td>
<td></td>
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<tr>
<td>2</td>
<td>Ensure the type of quantity of stone ballast is in accordance with the contract documents</td>
<td></td>
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<tr>
<td>3</td>
<td>Check gluing or welding of the seams. Must be done neatly and thoroughly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Review specifications for inspection requirements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>When near existing buildings take precautions with regards to glue fumes entering air intakes</td>
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</tbody>
</table>

#### Flashing and Sheet Metal Work

<table>
<thead>
<tr>
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<th>G.C. Initials &amp; Date</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Dissimilar metals should not be in contact with each other</td>
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<tr>
<td>2</td>
<td>Ensure proper fasteners are used</td>
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<tr>
<td>3</td>
<td>Avoid sharp cutting edges</td>
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<tr>
<td>4</td>
<td>Be alert for expansion requirements in material</td>
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<tr>
<td>5</td>
<td>Check all lapping and corner detail requirement</td>
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</table>

#### Skylights

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Compare size of roof curb with approved manufacturer’s product data. Confirm exact roof opening requirements.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Make sure curb is fastened to structure in accordance with Contract Documents and manufacturer’s recommendations. Confirm curb height off of roof elevation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Inspect flashing around mounting device.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Is there need for permanent or temporary protection at skylights (rails, etc.)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Compare glass with approved sample.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Sealants

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Compare all materials with approved samples.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Check size of space provided for caulking.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Inspect joints to ensure they are clean and dry.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Filler material to be kept dry during storage.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>If applicable, check paint material to be applied over caulking. Make sure they are compatible.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>If caulking is a specified color, compare sample with caulking in place.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Check appearance immediately after caulking has been applied. Address quality control immediately if issues exist.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**WEEKLY QUALITY CONTROL CHECKLIST**

**Division 7 – Thermal & Moisture Protection (con’t)**

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Verify the “backer rod” is the proper type and size for opening. Specifications will require closed cell or open cell. There is a difference.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Check the applicability of the intended sealant for the actual width of joint to be filled.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Some sealants require careful preparation of the joint before sealant application. In addition to being clean and dry, some sealants require priming of the surfaces to be sealed. Check this for each application.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Recheck all caulk joints after a major temperature change.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Roof Curbs**

| 1   | Study each prefabricated curb’s submittals data to ascertain whether it sits on the deck or on blocking fastened to the deck. This is essential if the curb is to be properly flashed. | | |
| 2   | If the curb is field built, ensure its dimensions will be compatible with whatever sits on it. | | |
| 3   | Field built curbs should be constructed of preservative treated wood. | | |
| 4   | All curbs must be securely fastened to the roof deck. | | |

**Spray Fireproofing**

| 1   | If a testing laboratory representative is to be present during fireproofing application, ensure that the rep is present & provides reports on a daily basis. | | |
| 2   | Ensure that the contractor or applicator is licensed by the fireproofing manufacturer. | | |
| 3   | Provide field sample for approval prior to starting work. | | |
| 4   | Observe manufacturer’s temperature requirements. | | |
| 5   | Continually verify thickness requirements. Thickness requirements may vary between steel members. | | |
| 6   | Compare the following approved material items with material delivered: | | |
|     | • Factory mixed mineral fibers. | | |
|     | • Factory mixed cementitious material. | | |
|     | • Primers. | | |
|     | • Reinforcing. | | |
| 7   | Check condition of structural steel before spray fireproofing application. If steel is to be sprayed, be sure it is not prime painted. | | |
| 8   | Check cleaning of adjacent surfaces. | | |
| 9   | Deck material may require de-oiling prior to spray applications. | | |
| 10  | Clips and hangers should be installed prior to application. | | |
| 11  | Store material off ground and cover. | | |
| 12  | Coordinate spray fireproofing with weather conditions. | | |
| 13  | Review all protection of adjacent areas and finishes. | | |
| 14  | Review clean-up procedure to avoid excessive mess and issues such as clogged drains. | | |
| 15  | Require a thorough daily clean-up. | | |
| 16  | Establish staging/mixing area. | | |
| 17  | Review thickness requirements with foreman and inspector. | | |
| 18  | Coordinate any prior installations, including piping, hangers, duct, partition framing, etc. | | |
| 19  | Review need for heating. | | |
| 20  | Discuss procedures for patching. | | |
| 21  | Clean up all extra water – prevent moisture from seeping through building. | | |
DIVISION 8 - DOORS & WINDOWS
PRE-WORK MEETING – QUALITY CONTROL AGENDA

PROJECT: ____________________________________________

Scope of Work: ____________________________ Date: _______________________

1. Review of Project Specifications
   a. Special Requirements
   b. Quality Control Tests Required

2. Review of Contract Documents
   a. Review all drawings for completeness and contractual responsibilities
   b. Review any coordination requirements from other trades

3. Review of Weekly Quality Control Checklist for the subcontractors scope of work

4. Procedure for Nonconforming Work

5. Material Storage Requirements

6. Subcontractor Responsibilities
   a. Quality Control – Primary responsibility is the subcontractors
   b. Requirement to report nonconforming work of the preceding contractor

7. Sample Construction
   a. Timing
   b. Approval Process
   c. Preservation of Approved Sample

8. Protection of Completed Work and Finishes
### Hollow Metal Doors and Frames

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>It is critical that inspection and inventorying occurs when material is received.</td>
</tr>
<tr>
<td>2</td>
<td>Store off ground with protection.</td>
</tr>
<tr>
<td>3</td>
<td>Check the following items immediately when received:</td>
</tr>
<tr>
<td></td>
<td>• Tag numbers.</td>
</tr>
<tr>
<td></td>
<td>• Prime paint.</td>
</tr>
<tr>
<td></td>
<td>• Louver (if specified).</td>
</tr>
<tr>
<td></td>
<td>• Opening for glass.</td>
</tr>
<tr>
<td></td>
<td>• Swing.</td>
</tr>
<tr>
<td></td>
<td>• Spreader bar on door frames.</td>
</tr>
<tr>
<td></td>
<td>• Gauge.</td>
</tr>
<tr>
<td></td>
<td>• Size.</td>
</tr>
<tr>
<td></td>
<td>• Cut-outs for any electrical devices, i.e., security cut-out, card reader, electric latch, etc.</td>
</tr>
<tr>
<td></td>
<td>• Reinforcing or backing plates.</td>
</tr>
<tr>
<td></td>
<td>• Welds, if welded construction.</td>
</tr>
<tr>
<td></td>
<td>• Silencer holes.</td>
</tr>
<tr>
<td></td>
<td>• Undercut.</td>
</tr>
<tr>
<td></td>
<td>• Label, if fire-rated.</td>
</tr>
<tr>
<td></td>
<td>• Hollow metal galvanized requirements.</td>
</tr>
<tr>
<td></td>
<td>• Undercoating</td>
</tr>
<tr>
<td>4</td>
<td>Frames to be adequately supported and braced during construction.</td>
</tr>
<tr>
<td>5</td>
<td>If installed in masonry walls or partitions, slush full with mortar the space between the masonry unit and the back side of the hollow metal frame. Advise the masonry foreman that he is responsible for the final product in masonry. Frame must be plumb and level.</td>
</tr>
<tr>
<td>6</td>
<td>Check anchors for proper quantity and type for affixing to adjacent wall or partition.</td>
</tr>
</tbody>
</table>

### Aluminum Doors and Frames

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ensure adequate protection is provided during shipping from plant.</td>
</tr>
<tr>
<td>2</td>
<td>Inspection when received.</td>
</tr>
<tr>
<td>3</td>
<td>Store off ground with protection.</td>
</tr>
<tr>
<td>4</td>
<td>Provide proper R/I opening. Double check with shop drawings.</td>
</tr>
<tr>
<td>5</td>
<td>Check the following items immediately when received:</td>
</tr>
<tr>
<td></td>
<td>• Color range.</td>
</tr>
<tr>
<td></td>
<td>• Hardware cut-outs.</td>
</tr>
<tr>
<td></td>
<td>• Size.</td>
</tr>
<tr>
<td></td>
<td>• Opening for glass.</td>
</tr>
<tr>
<td></td>
<td>• Swing.</td>
</tr>
<tr>
<td></td>
<td>• Cut-outs for electrical devices and conduit.</td>
</tr>
<tr>
<td></td>
<td>• Under cut.</td>
</tr>
<tr>
<td>6</td>
<td>Protect back side of aluminum which may be in contact with masonry or mortar. Is undercoating required?</td>
</tr>
<tr>
<td>7</td>
<td>Provide di-electric insulation between aluminum and support steel.</td>
</tr>
</tbody>
</table>

### Wood Doors

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Store in dry controlled space.</td>
</tr>
<tr>
<td>2</td>
<td>Check for proper grade, finish and materials.</td>
</tr>
<tr>
<td>3</td>
<td>Undercut as required.</td>
</tr>
<tr>
<td>4</td>
<td>Glass lites are proper size.</td>
</tr>
<tr>
<td>5</td>
<td>Seal top &amp; bottom</td>
</tr>
</tbody>
</table>
## WEEKLY QUALITY CONTROL CHECKLIST
### Division 8 – Doors & Windows (con’t)

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hardware/Hollow Metal Doors</strong></td>
<td><strong>Ensure UL Label rating is stamped on edge of fire rated doors and frames.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><strong>Pre-machining done properly, straight, true.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td><strong>Prefit and beveled, if specified.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td><strong>Bottom of doors must be sealed upon receipt. Usually requirement of painting subcontractor.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td><strong>Store on any edge and uniformly supported to avoid warping.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td><strong>Doors must be delivered in sufficient time before installation to allow them to “adjust” to the building environment.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td><strong>If doors are prefinished, maintain protective wrapper on doors, even after unit is hung.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td><strong>Check throat size and make sure proper installation clips are provided.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sliding Metal Fire Doors</strong></td>
<td><strong>Check for proper underwriter/FM classification.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><strong>Check door for proper size, dimensions and hardware.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td><strong>Check for safety devices.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td><strong>Check for proper anchors and support.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overhead Doors</strong></td>
<td><strong>Ensure tracks, track supports and braces are commercial or industrial grade.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><strong>Check door in open and closed position; inspect for proper closure and seals.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td><strong>Coordinate electrical rough-in.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td><strong>Refer to contract documents for “safety stops,” type and size of motor, if automatic, and all accessories.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td><strong>Check for proper structural support.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Impact Doors</strong></td>
<td><strong>Be certain the door frame is securely anchored. Check all fasteners and frame supports that are used.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><strong>Check for damage when received.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td><strong>Check color range.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td><strong>Check dimensions.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td><strong>Store windows off ground.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td><strong>Check shop primer. Touch-up, if necessary.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td><strong>Insulate any dissimilar metals.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td><strong>Do not caulk weep holes. Weep hole locations vary between systems.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td><strong>Ensure that caulking backer rod will work between window and adjoining surface.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td><strong>Windows to be set level, plumb and in alignment.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td><strong>Coordinate adjoining cleaning operations with finishes on window units.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td><strong>If mortar or concrete splashes on aluminum members, clean them immediately. Aluminum can be stained by these products.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td><strong>Check the fastening materials, methods and spacing for securing the windows to the adjacent construction.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td><strong>If wood blocking is used to shim or level the rough opening, it must be preservative treated wood.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td><strong>The window installer must use permanent, non-corrosive shims and spacers.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td><strong>Protect the interior window stool from subsequent damage by other interior trades.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td><strong>The stool must be continuously supported.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td><strong>Paint top and bottom.</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### WEEKLY QUALITY CONTROL CHECKLIST
**Division 8 – Doors & Windows (con’t)**

<table>
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<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Glass and Glazing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Inspect gasket material.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Check glass type with approved sample.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Do not allow protective tape to remain on glass.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Check for positive seal between glass and sash.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Check setting points.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Check for protection rails.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Do not store glass where exposed to elements. Water can etch glass in delivery crates.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Curtainwall System</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Review need for mock-up.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Check for damage when delivered.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Check clips or hanger devices.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Compare color with samples.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Compare accessory colors with panels.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Protection to curtainwall. During and after erection.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Refer to items in “Metal &amp; Aluminum Windows.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Coordinate perimeter caulking with system.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Hardware/Hollow Metal/Wood Doors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Ensure hardware templates have been sent by hardware supplier to hollow metal and/or other door manufacturers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Designate one individual to receive and check each delivery of hardware.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Designate a separate room on location to store and inventory all hardware.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Have the hardware supplier identify all hardware and ensure that all parts are complete.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>If required by specifications, hardware supplier should set-up and deliver key cabinet with keys. Check if keys are to be shipped direct to Owner.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Construction cylinders to be changed to permanent cylinders when Owner accepts building.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Some hardware may be required to be sent to door manufacturer installation prior to delivery of doors.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Compare hardware installed with hardware schedule.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Are loose cylinders required to be furnished to other subcontractors for incorporation in their product? (Overhead doors, aluminum entrance doors, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Review hollow metal installation procedure with carpenter foreman. Verify plumbness on a daily basis.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Damaged frames should not be installed. Report damages to project engineer or manager.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Review proper storage of wood doors.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Check for electronic hardware requirements. Who pulls the wire and makes connections?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DIVISION 9 - FINISHES
PRE-WORK MEETING – QUALITY CONTROL AGENDA

PROJECT: ___________________________________________________________

Scope of Work: ___________________________ Date: __________________________

1. Review of Project Specifications
   a. Special Requirements
   b. Quality Control Tests Required

2. Review of Contract Documents
   a. Review all drawings for completeness and contractual responsibilities
   b. Review any coordination requirements from other trades

3. Review of Weekly Quality Control Checklist for the subcontractors scope of work

4. Procedure for Nonconforming Work

5. Material Storage Requirements

6. Subcontractor Responsibilities
   a. Quality Control – Primary responsibility is the subcontractors
   b. Requirement to report nonconforming work of the preceding contractor

7. Sample Construction
   a. Timing
   b. Approval Process
   c. Preservation of Approved Sample

8. Protection of Completed Work and Finishes
### Weekly Quality Control Checklist

**Division 9 – Finishes**

#### Lath and Plaster

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Inspect type of studs required.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Check gauge spacing &amp; height of studs. Check for proper framing.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Check back-up accessories for wall mounted devices, i.e., wall stops, wall cabinets, etc.</td>
<td></td>
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</tr>
<tr>
<td>4</td>
<td>Check type and size of lath along with all accessories.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Check methods of attaching lath to studs.</td>
<td></td>
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</tr>
<tr>
<td>6</td>
<td>Review the type of plaster specified.</td>
<td></td>
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<tr>
<td>7</td>
<td>Check the thickness and coats required.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>For high areas, discuss how to avoid staging marks.</td>
<td></td>
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</tr>
<tr>
<td>9</td>
<td>Review type of permanent lighting required. Temporary lighting to be installed to simulate permanent lighting.</td>
<td></td>
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</tr>
<tr>
<td>10</td>
<td>Check provisions to protect adjacent materials from plaster.</td>
<td></td>
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</tr>
<tr>
<td>11</td>
<td>Review type of finish.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Provide control joints per specs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Control curing time between application of subsequent coats. Sufficient time for controlled drying must be allowed.</td>
<td></td>
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</tr>
<tr>
<td>14</td>
<td>Do not allow temporary heat to be direct against freshly plastered surfaces. Too rapid drying will occur and produce surface crazing.</td>
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<td></td>
</tr>
</tbody>
</table>

#### Gypsum Drywall

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Check framing around duct openings.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Check thickness, length and width of gypsum wall board.</td>
<td></td>
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</tr>
<tr>
<td>3</td>
<td>Check type of drywall required.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Check if drywall is to be installed horizontal or vertical.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Check if rated walls are properly identified on the drawings.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Check temperature requirements for spackle.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Compare accessories with approved data.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Include control joints as required by specifications or building standards.</td>
<td></td>
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<tr>
<td>9</td>
<td>Install gypsum board approximately ½” above floor surface to preclude “wicking” of water from floor.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Visually check alignment of tracks and studs in long partitions before gypsum board is installed to avoid “waves” in wall.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Check for blocking in partition for support of railings, toilet accessories, wall hung cabinets, etc. before applying gyp board surface.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Ensure that walls and partitions to receive sound or thermal insulation and that it is a quality installation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Learn required spacing for fasteners, nails or screws, and check for conformity to those requirements.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>If partition is to terminate at fasteners, nails or screws, must not exceed 1/2 from inside of partition.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Make initial quality check of drywall finishing.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Review clearances around penetrations to ensure proper fire sealant and safing installations.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Review quality control of drywall finishing where lighting will “wash” drywall surface. Imperfections in drywall will be highlighted with certain types of lighting.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Drywall finishing at base of walls should be smooth in order to eliminate any waves in vinyl base.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Verify with all trades that rough in is complete.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Check if local inspections are required.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Verify required level of wall finish.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Monitor humidity and temperature.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Review The Company’s Water Intrusion Management Plan</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Ceramic Tile

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Beware of environmental conditions, temperature, relative humidity, etc. prior to setting ceramic tile.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Check all surfaces to be covered with tile to ensure they are square and plumb. They shall be clean, dry, firm and oil-free surfaces.</td>
<td></td>
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</tr>
<tr>
<td>3</td>
<td>Check if a leveling coat is to be applied to walls or ceilings prior to installing tile.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Compare tile received with approved color charts and/or samples.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Tile to be inspected for size, shape, texture, color and pattern. Cuts should be kept to a minimum. Review proposed layouts with foreman.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Upon delivery, check quantity and check for damaged tile.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Accessories on the tile work should be placed so they are evenly spaced, properly centered with tile joints, level, plumb and true to the correct location.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Verify color of grout and type of grout.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Inspect for all required expansion and control joints.</td>
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<tr>
<td>10</td>
<td>Check sealant required in control or expansion joints.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Setting the cove tile base in a room to receive ceramic tile wall and floor tile is a critical operation. The cove base must be absolutely level &amp; set to the high point of the floor.</td>
<td>If the floor is too uneven, solve that problem before proceeding further with wall or floor tile installation.</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Beware of ceramic wall tile to be installed beneath “wall washer” lighting. Every imperfection will be visible and emphasized. Review with project manager and architect.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Check with installing mechanic on basic layout for the wall and floor. Avoid narrow “cuts,” especially in highly visible areas, i.e., near door.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Verify the opening for toilet accessories. Oversized openings will be a costly fix.</td>
<td></td>
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<tr>
<td>15</td>
<td>Protect installed ceramic tile from welding spatter, if welding must be done subsequent to installation of the ceramic tile.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>If contract documents require waterproof setting mastic, verify by checking containers.</td>
<td></td>
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<tr>
<td>17</td>
<td>Check if any type of waterproofing is required prior to setting floor tile.</td>
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</tr>
<tr>
<td>18</td>
<td>Verify if floor is to be depressed.</td>
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<tr>
<td>19</td>
<td>Be sure floor drains are at a correct elevation.</td>
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<tr>
<td>20</td>
<td>Verify the floor elevation of adjacent areas at common openings is as designed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Verify tile is all from same run and batch.</td>
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<td></td>
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</tbody>
</table>

### Quarry Tile

<table>
<thead>
<tr>
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<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Same as for ceramic tile walls and floors.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Verify if floor is to be depressed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Control joints must coincide with joints in slab.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Some exotic grouts are sometimes specified for these floors, i.e., epoxy, furan, etc. Know what is specified and ensure that is what is installed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Verify tile is all from same run and batch.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Terrazzo

<table>
<thead>
<tr>
<th>No.</th>
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<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Check if a depressed slab is required.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Inspect concrete surface. Surface must be free from oil, dirt, curing compounds, hardeners, etc. If not, an acid wash may be required or roughing of surface may be necessary for bonding.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Compare representative chips of marble with approved samples.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Inspect mortar to be used.</td>
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<tr>
<td>5</td>
<td>Inspect control strips and expansion joints.</td>
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<td></td>
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<tr>
<td>6</td>
<td>Check gauge of galvanized wire, if required.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Check for special patterns or insets.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### WEEKLY QUALITY CONTROL CHECKLIST

#### Division 9 – Finishes (con’t)

<table>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Epoxy Terrazzo</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Same as Terrazzo.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Compare the epoxy resins with approved data.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Compare all accessories with approved data. Some alloys are not compatible with epoxy.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Vapor barrier under slab is generally mandatory.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Be absolutely certain the substrate is clean and free of any substances, including curing compounds and sealers, which could affect adhesion between it and the epoxy terrazzo. Do not proceed with installation of topping, unless you are satisfied.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Epoxy terrazzo cannot generally be installed on a slab below grade or a slab which may have moisture permanently in it.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Epoxy terrazzo is installed as a very thin topping, be sure the initial application of epoxy mix is sufficiently thick so that subsequent grinding operations will not reduce it below the minimum required thickness.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Timing between application of the prime coat on the substrate and the epoxy mix to the primer coat is critical. Be sure the mechanics working your job understand these limitations.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Review all ventilation needs. Fully review the surrounding work force and occupied areas and any impact the odors may have.</td>
<td></td>
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<tr>
<td></td>
<td><strong>Precast Terrazzo</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Inspect precast plant periodically to compare fabrication with approved samples.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Inspect the type of material to be used to attach precast to walls, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Acoustical Ceilings</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Starting points for ceiling grid are to be established in each area by ceiling subcontractor prior to starting overhead mechanical and electrical work &amp; other items which need to be coordinated w/ ceiling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Establish the method of hanging ceiling grid. Eliminate interference with other trades early on.</td>
<td></td>
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</tr>
<tr>
<td>3</td>
<td>Compare all ceiling accessories with approved samples.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Inspect type, gauge and spacing of hangers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Hanger wires must be secured to the building structure, not to pipe, duct or conduit. Do not penetrate roof deck.</td>
<td></td>
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</tr>
<tr>
<td>6</td>
<td>Compare ceiling molding and grid with approved samples.</td>
<td></td>
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<tr>
<td>7</td>
<td>Compare ceiling panels with approved samples.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Check manufacturer’s recommendations regarding temperature requirements during installation. Tiles will droop or warp with excessive humidity.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>If you are entitled by contract to receive prefab exterior corners on edge trim, don’t settle for field cuts and pop rivets.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Check and re-level the ceiling after loading has been applied to the suspension system, i.e., lighting fixtures, diffusers, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Avoid whenever possible, narrow slivers of ceiling tile at edges of the field. Endeavor to re-arrange the ceiling layout to eliminate this condition.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Check if local inspections are required.</td>
<td></td>
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<tr>
<td></td>
<td><strong>Vinyl Composition Tile</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Inspect flooring on which the resilient material is to be placed to ensure bonding. No oil, grease, dirt or curing compounds. Some may be deleterious to the adhesive.</td>
<td></td>
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<tr>
<td></td>
<td>• If there is question of excessive moisture being present in subsurface do not apply flooring without test.</td>
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<tr>
<td>2</td>
<td>Check that all joints and cracks are filled with an approved material prior to installation.</td>
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<tr>
<td>3</td>
<td>Check level of floor prior to installation, flash patching may be required. Any existing moisture may cause problems with patching material.</td>
<td></td>
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<tr>
<td>4</td>
<td>Compare resilient flooring material with approved samples.</td>
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</tbody>
</table>
## WEEKLY QUALITY CONTROL CHECKLIST
### Division 9 – Finishes (con’t)

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</thead>
<tbody>
<tr>
<td>5</td>
<td>Compare the adhesive material with approved data.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Check the laying pattern to ensure that opposite borders are of equal width. Cut tiles only at base and outlets in floor.</td>
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</tr>
<tr>
<td>7</td>
<td>Check that adhesive is being applied in a proper manner and at a proper rate.</td>
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<tr>
<td>8</td>
<td>Check manufacturers’ recommendations for proper drying time for adhesive.</td>
<td></td>
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<tr>
<td>9</td>
<td>Check for tight joints, straight lines and smooth level surface.</td>
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<tr>
<td>10</td>
<td>Protect floor from damage with an approved material.</td>
<td></td>
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<tr>
<td>11</td>
<td>Verify tile is from same run/batch.</td>
<td></td>
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<tr>
<td>12</td>
<td>Confirm leveling requirements. Who pays for the leveling?</td>
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</tbody>
</table>

### Resilient Sheet Flooring

<table>
<thead>
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<tbody>
<tr>
<td>1</td>
<td>Sheet flooring to be rolled with approved equipment.</td>
<td></td>
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</tr>
<tr>
<td>2</td>
<td>Check for air bubbles and wrinkles.</td>
<td></td>
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<tr>
<td>3</td>
<td>Check the adhesive to be sure for compatibility with substrate and with flooring.</td>
<td></td>
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</tr>
<tr>
<td>4</td>
<td>Subsurface conditions and requirements are the same as vinyl composition tile.</td>
<td></td>
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</tr>
<tr>
<td>5</td>
<td>Verify tile is from same run/batch.</td>
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<td></td>
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</tbody>
</table>

### Painting

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1</td>
<td>Compare paint with approved color schedules.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Inspect surface to be painted prior to paint application. Fill in voids, joints, cracks, etc. with an approved material.</td>
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<tr>
<td>3</td>
<td>Check moisture content of surface to be painted.</td>
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<tr>
<td>4</td>
<td>Check manufacturer’s recommendation regarding temperature requirements for application.</td>
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<td></td>
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<tr>
<td>5</td>
<td>Inspect the application for thickness and coverage for each coat.</td>
<td></td>
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</tr>
<tr>
<td>6</td>
<td>Check type of application, i.e., brush, roller or spray.</td>
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<td></td>
</tr>
<tr>
<td>7</td>
<td>Prior to painting caulked joints, check if caulk material is compatible with paint.</td>
<td></td>
<td></td>
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<tr>
<td>8</td>
<td>Make sure top &amp; bottom of wood doors are sealed immediately upon delivery.</td>
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<td></td>
</tr>
<tr>
<td>9</td>
<td>Assure proper preparation of the surface to be painted, and assure the required number of coats are applied.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>If a wall covering is to be applied, be sure sizing is applied to the wall surface prior to application of the wall covering.</td>
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</tbody>
</table>

### Carpet

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1</td>
<td>Review subsurface conditions prior to installation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Discuss method of delivering and route to be taken into building.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Compare carpet delivered with approved samples.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Clean surfaces of floor that carpet is to be placed. Make sure surface &amp; carpet are dry.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Compare mastic to be used with approved samples or data.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Compare base material and mastic with approved samples.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Discuss cut-outs with participating trades. Ensure sizes are agreed upon by all parties.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Review attic space quantities and storage locations.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Check specifications if carpet is to be cleaned prior to Owner use.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Wall Coverings

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Inspect surface to be covered. Any bumps may show up in wall covering.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Compare material delivered with approved sample.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Compare mastic with approved samples or data.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Check manufacturers’ recommendation regarding temperature requirements and other data.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Make sure pattern matches.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Ensure joints butt, no overlap and space between sheets.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Remove all air bubbles.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Check plumbness and all cuts for neatness.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Review sizing requirements.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PROJECT: ________________________________

Scope of Work: __________________________ Date: _______________________

1. Review of Project Specifications
   a. Special Requirements
   b. Quality Control Tests Required

2. Review of Contract Documents
   a. Review all drawings for completeness and contractual responsibilities
   b. Review any coordination requirements from other trades

3. Review of Weekly Quality Control Checklist for the subcontractors scope of work

4. Procedure for Nonconforming Work

5. Material Storage Requirements

6. Subcontractor Responsibilities
   a. Quality Control – Primary responsibility is the subcontractors
   b. Requirement to report nonconforming work of the preceding contractor

7. Sample Construction
   a. Timing
   b. Approval Process
   c. Preservation of Approved Sample

8. Protection of Completed Work and Finishes
# WEEKLY QUALITY CONTROL CHECKLIST
## Division 10 – Specialties

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Toilet Partitions and Urinal Screens</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Verify if partitions are ceiling or floor mounted.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>If ceiling mounted, check dimension of holes in miscellaneous iron.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Compare partition colors with approved color charts.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Verify toilet accessories that are part of toilet partition contract.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Verify type of partition and screen material, i.e., stainless steel, porcelain, metal, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Verify size of any cutouts.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Check hardware and door swing.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Where screens and partitions are to be anchored to a wall, be sure provisions have been made for secure and permanent anchorage.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Where such wall anchorages are made through ceramic tile, check the tile after installation of the partitions for cracks and spalls. These are the responsibility of the toilet partition subcontractor.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>If touch-up painting is needed to correct minor scratches and abrasions, be sure it is done properly.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Verify gauges of doors, panels and pilasters.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Review quality of installation prior to installer leaving the project. Pay attention to spacing between doors and jambs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Verify blocking requirements.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Lockers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Check the gauge of lockers, doors and door frames.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Check size of lockers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Check hardware, locks, number, hook and shelves, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Compare color of lockers to approved color chart.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Check filler material and sloping tops, if required.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Check alignment, and if lockers are well secured.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Verify blocking requirements.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Fire Extinguishers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Check if cabinet is required. Is it recessed or wall mounted?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Verify size of cabinet.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Check type(s) of extinguishers required.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>May have Fire Marshal check extinguishers after they are placed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Protect the cabinet against damage by other finishing trades.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Verify that rough openings are the correct dimensions.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td><strong>Toilet Accessories</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Check for blocking required in walls to receive and fasten toilet accessories.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Verify opening dimensions in walls to receive toilet accessories.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Verify that all toilet accessories are in accordance with approved data, i.e., manufacturer, material, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Inventory the material as it arrives on the job. Do not wait until installation begins.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DIVISION 11 - EQUIPMENT
PRE-WORK MEETING – QUALITY CONTROL AGENDA

PROJECT: ___________________________________________________________

Scope of Work: ___________________________ Date: _______________________

1. Review of Project Specifications
   a. Special Requirements
   b. Quality Control Tests Required

2. Review of Contract Documents
   a. Review all drawings for completeness and contractual responsibilities
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   b. Approval Process
   c. Preservation of Approved Sample

8. Protection of Completed Work and Finishes
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<tr>
<td></td>
<td><strong>Kitchen Equipment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Shop drawings indicating service stub-ups to allow the installation of underground service piping.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Coordinate approved kitchen shop drawings with the mechanical/ electrical contractors.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Verify gauges, type of material &amp; size of counters, benches, sinks, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Verify the exhaust system required, coordinate with the mechanical exhaust system.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Check fire protection requirement, i.e. at hoods (ansul systems).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Is there sufficient support for the hood exhaust?</td>
<td></td>
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</tr>
<tr>
<td>7</td>
<td>Check wall, reinforcing requirements for shelving equipment, including blocking.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Is floor and ceiling installed prior to installation of kitchen equipment?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Compare all equipment with approved data.</td>
<td></td>
<td></td>
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<tr>
<td>10</td>
<td>Compare all plumbing and electrical devices with approved data.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Determine floor elevation and ceiling heights prior to installing equipment.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Laboratory Furniture</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Check color and finish of furniture.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Check quality of jointing work for lab tops. Sealer colors to match tops.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Prior to installation of unistruts, determine floor elevation in relation to window, door, fume hoods and ceiling heights. Furniture can be adjusted up, but not down.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Verify size, height and location of unistruts.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Confirm that the electrical and mechanical contractors will utilize the lab unistrut for attaching mechanical and electrical service pipe. If not, coordination must be done between the three contractors.</td>
<td></td>
<td></td>
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<tr>
<td>6</td>
<td>Ensure the service ledges are in accordance with approved contract documents. There are different types.</td>
<td></td>
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</tr>
<tr>
<td>7</td>
<td>All rough-in piping and conduit should be installed on the unistrut prior to installation of furniture (base cabinets). Piping should also be tested and insulated. This eliminates damage to furniture.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Prior to wall installation, make sure wall will have proper blocking or support to receive wall cabinets.</td>
<td></td>
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<tr>
<td>9</td>
<td>When base cabinet tops are delivered, compare the following approved samples:</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>- Type of top.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Thickness of top.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Cut-out dimensions.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Shape of top.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Check for damage.</td>
<td></td>
<td></td>
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<tr>
<td>10</td>
<td>Fume hoods - check the following:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Height of completed hood.</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>- Will hood fit thru all openings from dock to final resting place. (Check as early as possible.)</td>
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<tr>
<td></td>
<td>- Does manufacturer pre-wire hood? If so, has this work been done?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Are light fixtures included in lab furniture contract? Have they been received or installed? Are there any special requirements? Height? Explosion proof?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>All component parts - Mechanical and electrical usually supplied by lab furniture supplier. Then given to the mechanical and electrical contractors for installation after furniture is in place.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Compare color of wiremold with approved sample.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Review temperature requirements by manufacturer when sealing and joint material is being used.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td><strong>Process Equipment – Shop Drawing Review</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Verify overall scope of supply with purchase order.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Verify equipment is the size anticipated under the design &amp; will fit in the room allotted.</td>
<td></td>
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</tr>
<tr>
<td>3</td>
<td>Verify size and connection type of all inlets and outlets.</td>
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</tr>
<tr>
<td>No.</td>
<td>Item</td>
<td>Sub Initials &amp; Date</td>
<td>G.C. Initials &amp; Date</td>
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</tr>
<tr>
<td>4</td>
<td>Verify if any box outs are needed in the concrete construction to allow for installation.</td>
<td></td>
<td></td>
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<tr>
<td>5</td>
<td>Verify who is supplying the Anchor Bolts.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Verify if the piece of equipment needs to be installed prior to installing the roof.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Review electrical components vs. MCC On Lines to verify compatibility.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Review I/O connections to verify compatibility to the SCADA system.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Copy Electrical, Instrumentation &amp; Mech. Subs on the Shop Drawings (have them respond in writing if they see any conflicts with their scope of work.)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Process Equipment – Fabrication and Delivery**

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Create &quot;job specific&quot; Fabrication and Delivery Matrix and update weekly (see attached material expediting log – Pg 17-3).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Get in writing from manufacturer estimated lead time after release for the equipment to be delivered.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Determine if there are special lifting requirements (Will the cranes on site be adequate for picking this equipment).</td>
<td></td>
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</tr>
<tr>
<td>4</td>
<td>Verify upon receipt that all materials anticipated on being needed are delivered.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>If material is going to be delivered early and stored follow all long term storage requirements and document that they are being followed. (Are heaters needed, rotate the motors, grease &amp; lube, etc.)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Process Equipment – Installation & Start Up**

<table>
<thead>
<tr>
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<tr>
<td>1</td>
<td>Prepare installation packet for field personnel with all need drawings and contact information.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Tighten all bolts to proper torque requirements.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Have the electrician sign documents demonstrating that all electrical components have been installed per the documents and that continuity has been checked.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Have the Instrumentation Sub-Contractor sign documents demonstrating that all instruments and controls have been installed per the documents and that they have trouble shoot to their fullest extent before start-up.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Perform leak testing of equipment if necessary.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Create equipment start-up and training schedule and coordinate with the Owner’s personnel.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Schedule equipment vendors in accordance with the above schedule.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Verify rotation of the equipment if necessary by “bumping” prior to full start-up.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Determine if flow is needed for the start-up of the equipment and where this flow will be exhausted during start-up.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Have manufacturer start-up personnel sign all required documents (at a minimum a start-up report and training certificate). Document the Owner’s personnel who attended these sessions. (See attached example – Pg. 17-14)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Verify that all lubricants have been installed and are up to the specifications required by the equipment manufacturer.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Do not grout base plates until after manufacturer representative has signed off that the installation is acceptable.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Ensure Manufacturer’s O &amp; M’s for equipment storage are reviewed</td>
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</tbody>
</table>

**Owner Furnished Equipment (OFE)**

<table>
<thead>
<tr>
<th>No.</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Understand which items are Owner Furnished, Owner Installed (OFOI) and Owner Furnished, Contractor Installed (OFCI).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Review OFE Manuals for rough-in requirements (electrical, mechanical, plumbing, etc...)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Understand storage requirements of OFCI equipment.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PROJECT: ____________________________________________________________

Scope of Work: ___________________________   Date: __________________________

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<tr>
<td>1</td>
<td>Review approved submittals.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Check condition of material upon receipt.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Review storage requirements.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Review requirements for temperature and humidity during installation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Verify that blocking is installed.</td>
<td></td>
<td></td>
</tr>
</tbody>
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DIVISION 13 - SPECIAL CONSTRUCTION
PRE-WORK MEETING – QUALITY CONTROL AGENDA

PROJECT: ___________________________________________________________

Scope of Work: ____________________________ Date: ____________________________

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8. Protection of Completed Work and Finishes
### WEEKLY QUALITY CONTROL CHECKLIST

**Division 13 – Special Construction**

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</thead>
</table>

#### Metal Buildings - Shop Drawing Review

1. Review Shop Drawings for Dimensional Requirements
2. Determine missing items from metal building scope.
3. Determine who is to design anchor bolts and purchase them in time to have them installed prior to concrete placements
4. Verify that building load conditions include crane requirements if necessary
5. Send metal building manufacturer copies of all related submittals (cranes, overhead doors, hanging HVAC equipment, etc.)

#### Metal Buildings - Fabrication, Delivery & Installation

1. Hold metal building review meeting. Invite all parties involved (HVAC, mechanical, electrical, installer.)
2. Determine needed delivery date and schedule fabrication based on delivery needs.
3. Determine who will cut in roof penetrations and review details with installer.
4. Store all materials in accordance with manufacturer requirements.
5. All liner panels should be covered and free from moisture promoting environments.
6. Determine installation schedule and present it to the installer.
7. Review all safety requirements with Installer.
8. Perform all inspections in accordance with specifications & local permit requirements.
9. Upon completion, schedule manufacturer to the job site to perform weather tightness inspection.

#### Instrumentation – Shop Drawing Review

1. Review specified manufacture against the supplied models.
2. Review electrical connections and I/O capabilities.
3. Review enclosure types (NEMA4x etc.).
4. Should flow meters be rated for submergence?
5. Review connection type (flange, NPT, etc.)
7. Send copy of shop drawings to the electrical subcontractor.
8. Review length of power and communication cable lengths to verify that no splices are needed.

#### Instrumentation - Delivery & Installation

1. Make sure all devices are tagged and labeled for easy field installation.
2. Make sure provisions are called for in designs that instruments can be read without the use of a ladder.
3. Use a compatible pipe dope when threading taped instruments into process streams.
4. Verify all installations of water tight devices are complete by the proper installation of a potting compound.
5. Have the electrical subcontractor verify continuity of electrical terminations.
6. Have the Instrumentation Subcontractor verify and complete a sign off on a certificate of Proper Installation. (see attached example – Pg. 17-11)
7. Verify that manufacturer representative has reviewed the installation and performed any calibrations if necessary.
DIVISION 14 - ELEVATORS
PRE-WORK MEETING – QUALITY CONTROL AGENDA

PROJECT: __________________________________________

Scope of Work: ___________________________ Date: ________________

1. Review of Project Specifications
   a. Special Requirements
   b. Quality Control Tests Required

2. Review of Contract Documents
   a. Review all drawings for completeness and contractual responsibilities
   b. Review any coordination requirements from other trades

3. Review of Weekly Quality Control Checklist for the subcontractors scope of work

4. Procedure for Nonconforming Work

5. Material Storage Requirements

6. Subcontractor Responsibilities
   a. Quality Control – Primary responsibility is the subcontractors
   b. Requirement to report nonconforming work of the preceding contractor

7. Sample Construction
   a. Timing
   b. Approval Process
   c. Preservation of Approved Sample

8. Protection of Completed Work and Finishes
## WEEKLY QUALITY CONTROL CHECKLIST
### Division 14 – Elevators

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Elevators</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Check and recheck the location of the shaft cylinder, if a hydraulic elevator.</td>
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<tr>
<td>2</td>
<td>Ladder to pit for each elevator.</td>
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<tr>
<td>3</td>
<td>Coordinate underground work for hydraulic oil lines.</td>
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<tr>
<td>4</td>
<td>All access doors to machine rooms to be fire rated.</td>
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<tr>
<td>5</td>
<td>Inserts for guide rails to be installed during construction of walls. Check for other embed requirements.</td>
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<tr>
<td>6</td>
<td>Ensure the electrical power designated for the elevators compare to the electrical requirements of the chosen elevator company.</td>
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<tr>
<td>7</td>
<td>Ensure there is adequate power, temporary or permanent, available for testing of elevator and in construction phase.</td>
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<tr>
<td>8</td>
<td>Prior to installation of elevator shaft walls, compare size with elevator manufacturer.</td>
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<tr>
<td>9</td>
<td>Check dimension of all openings.</td>
<td></td>
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<tr>
<td>10</td>
<td>No equipment other than elevator equipment is allowed in elevator machine room. Check spacing requirements of electrical equipment allowed in machine room.</td>
<td></td>
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<tr>
<td>11</td>
<td>Check that any permanent structural beams traversing the top of the hoistway do not violate code requirements for over-travel and top of cab clearances.</td>
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<tr>
<td>12</td>
<td>Check if all accessories are complete as follows:</td>
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<tr>
<td></td>
<td>• Lights.</td>
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<td></td>
<td>• Telephone.</td>
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<td></td>
<td>• Call system. (Hospital codes.)</td>
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<td></td>
<td>• Fire system.</td>
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<td></td>
<td>• Signaling device.</td>
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<td></td>
<td>• Operation and leveling.</td>
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<td></td>
<td>• Door operation.</td>
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<td></td>
<td>• Door size.</td>
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<tr>
<td></td>
<td>• Intercommunicating system.</td>
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<td></td>
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<tr>
<td></td>
<td>• Floor covering.</td>
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<td></td>
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<tr>
<td></td>
<td>• Handrails.</td>
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<td></td>
<td>• Ceiling.</td>
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</tr>
<tr>
<td></td>
<td>• Elevator wall finishes.</td>
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<tr>
<td>13</td>
<td>Protect cab with blankets, etc. while being used prior to Owner move-in.</td>
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<tr>
<td>14</td>
<td>Check ventilation requirements of elevator shaft.</td>
<td></td>
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<tr>
<td>15</td>
<td>Review available storage area for hydraulic fluids.</td>
<td></td>
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<tr>
<td>16</td>
<td>Check domestic materials/equipment requirements.</td>
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<tr>
<td>17</td>
<td>Check sump pit grating.</td>
<td></td>
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<tr>
<td>18</td>
<td>Protect shaft openings during construction.</td>
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<tr>
<td>19</td>
<td>Obtain state inspectors checklist &amp; review prior to formal inspection.</td>
<td></td>
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<tr>
<td>20</td>
<td>Check if inspection is also required by local authorities.</td>
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<tr>
<td><strong>Cranes - Shop Drawing Review</strong></td>
<td></td>
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<tr>
<td>1</td>
<td>Review shop drawings for dimensional requirements (centered over door opening or crane rail span).</td>
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<tr>
<td>2</td>
<td>Verify clearance above and below the end trucks.</td>
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<tr>
<td>3</td>
<td>Verify side clearance.</td>
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<tr>
<td>4</td>
<td>Verify that cranes are the proper size.</td>
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<tr>
<td>5</td>
<td>Send coordinating trades the submittals (electrician, metal building manufacturer, precast supplier, etc.)</td>
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<tr>
<td>6</td>
<td>Verify minimum lifting height is obtainable.</td>
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<td>7</td>
<td>Review the controls scenario.</td>
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<td>8</td>
<td>Determine who is to supply the crane beams, rails, end stops (often excluded from scope).</td>
<td></td>
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<tr>
<td>9</td>
<td>How and who is supplying the beam connection to the pre-cast embed plates.</td>
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</tbody>
</table>
### WEEKLY QUALITY CONTROL CHECKLIST
**Division 14 – Elevators (con’t)**

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
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<tbody>
<tr>
<td></td>
<td><strong>Cranes - Fabrication, Delivery &amp; Installation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Determine if the crane needs to be installed before the roofs are installed.</td>
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<tr>
<td>2</td>
<td>Determine needed delivery date and schedule fabrication based on delivery needs.</td>
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<tr>
<td>3</td>
<td>Review the electrical connections and determine whose scope they are in.</td>
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<tr>
<td>4</td>
<td>Schedule manufacturer for start-up, load testing &amp; training (complete necessary documents).</td>
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</tr>
</tbody>
</table>
PROJECT: 

Scope of Work: ___________________________  Date: ___________________________

1. Review of Project Specifications
   a. Special Requirements
   b. Quality Control Tests Required

2. Review of Contract Documents
   a. Review all drawings for completeness and contractual responsibilities
   b. Review any coordination requirements from other trades

3. Review of Weekly Quality Control Checklist for the subcontractors scope of work

4. Procedure for Nonconforming Work

5. Material Storage Requirements

6. Subcontractor Responsibilities
   a. Quality Control – Primary responsibility is the subcontractors
   b. Requirement to report nonconforming work of the preceding contractor
   c. Review commissioning requirements
   d. Review owner training requirement

7. Sample Construction
   a. Timing
   b. Approval Process
   c. Preservation of Approved Sample

8. Protection of Completed Work and Finishes
### WEEKLY QUALITY CONTROL CHECKLIST

**Division 15 – Mechanical**

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<tr>
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</thead>
<tbody>
<tr>
<td></td>
<td><strong>Piping - General</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Check all delivered pipe for size (diameter), schedule (wall thickness), and fabrication specification for steel pipe, an ASTM number.</td>
<td></td>
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<tr>
<td>2</td>
<td>When project involves manual field welding, check specifications for requirements such as:</td>
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<tr>
<td></td>
<td>• Current welder certification papers.</td>
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<tr>
<td></td>
<td>• Welding procedures.</td>
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<tr>
<td></td>
<td>• Weld identification (mark of each certified welder).</td>
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<tr>
<td></td>
<td>• Required electrodes.</td>
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<td></td>
<td>• Daily check of welding machine output.</td>
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<td></td>
<td>• Chill rings (back-up rings with spacer studs).</td>
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<td></td>
<td>• Weld sampling procedures and frequency.</td>
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<tr>
<td>3</td>
<td>When project involves special and exotic machine field welding, i.e., inert gas welding, check specifications for requirements such as:</td>
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<td></td>
<td>• Special inspections.</td>
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<td></td>
<td>• Periodic machine validation.</td>
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<tr>
<td></td>
<td>• Sampling program.</td>
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<tr>
<td></td>
<td>• Pipe cleaning and purging.</td>
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<tr>
<td>4</td>
<td>All copper pipe looks similar. Drawings and specifications may call for Type M, L or K. Ensure proper type is used. Review medical gas section (15020) for special piping requirements.</td>
<td></td>
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<tr>
<td>5</td>
<td>Reinforced concrete pipe comes in various “weights.” Check documents for special requirements (reinforcing, lift hole plugs, grease for seals, etc.);</td>
<td></td>
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<tr>
<td>6</td>
<td>Storm and sanitary drainage pipe comes with a variety of fittings, i.e., no-hub, tyseal, etc. Check specifications vs. delivered pipe.</td>
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<tr>
<td>7</td>
<td>Check bolts used with flanged pipe. Substandard imported bolts and nuts may be mistakenly shipped to the job. Check the bolt container for the proper ASTM designation.</td>
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<tr>
<td>8</td>
<td>Plastic pipe is generally joined by a solvent welding process. Be sure the solvent or “glue” meets the pipe manufacturer’s recommendations.</td>
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<tr>
<td>9</td>
<td>Check Firestopping requirements. Whose contract is it in?</td>
<td></td>
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<tr>
<td>10</td>
<td>Pipe system testing may be required by the local municipality, by the contract documents, or by the Owner’s insurance underwriter. Know and understand the testing requirements for the project.</td>
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<tr>
<td>11</td>
<td>Record test information in daily report. If testing agency is not on-site, then Superintendent should verify test.</td>
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<tr>
<td></td>
<td><strong>Below Ground Piping</strong></td>
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<td></td>
</tr>
<tr>
<td>1</td>
<td>Ensure that the contractor has obtained required permits.</td>
<td></td>
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<tr>
<td>2</td>
<td>Check road opening for safety, permits, flag person, etc.</td>
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<tr>
<td>3</td>
<td>Prior to starting work, determine locations and elevations of all existing piping, conduit, etc. This will decrease the possibility of interferences. Public utility services are available for locating existing installations.</td>
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<tr>
<td>4</td>
<td>Verify inverts of all existing pipe especially pipe to be tied-into.</td>
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<tr>
<td>5</td>
<td>The trench must be at correct elevation and proper pitch, if gravity flow piping is involved. Review safety issues as they relate to trenching.</td>
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<tr>
<td>6</td>
<td>Check trench bottom for firmness. The bedding must be of proper material and proper thickness. No rocks or sharp objects can be left in the trench which could damage or puncture the installed pipe.</td>
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<tr>
<td>7</td>
<td>The pipe must be supported uniformly along its length. This may require depressions at the jointing locations.</td>
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<tr>
<td>8</td>
<td>Ensure required concrete thrust blocks, supports and encasements are provided and fully cured.</td>
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</table>
# WEEKLY QUALITY CONTROL CHECKLIST
## Division 15 – Mechanical (con’t)

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>9</td>
<td>Check for proper insulation type, thickness and installation procedure.</td>
<td></td>
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</tr>
<tr>
<td>10</td>
<td>Underground pipe must be tested and inspected, when required, before the joints and fittings are covered by insulation or backfill.</td>
<td></td>
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<tr>
<td>11</td>
<td>If joints are to remain exposed during a high pressure test, ensure that proper backfill is done over other portions of pipe to eliminate a blow out.</td>
<td></td>
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<tr>
<td>12</td>
<td>Check specifications for backfill material. Is marking tape or wire required?</td>
<td></td>
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<tr>
<td>13</td>
<td>Underground pipe backfill must be compacted. Review requirements with related foreman and, where applicable, the testing agency.</td>
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<tr>
<td>14</td>
<td>Make sure correct gaskets and mechanical joints (mega lugs) are used.</td>
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<tr>
<td>15</td>
<td>Is pipe wrap required?</td>
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<tr>
<td>16</td>
<td>Keep accurate as-builds and keep up-to-date.</td>
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## Above Ground Piping

<table>
<thead>
<tr>
<th>No.</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Hangers and supports must be of proper type, proper size and proper spacing.</td>
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<tr>
<td>2</td>
<td>Hangers &amp; supports must be fastened to a solid, stable element of the building, not hung from another pipe, conduit duct or ceiling suspension element.</td>
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<tr>
<td>3</td>
<td>Review special requirements for all high temperature piping support.</td>
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<tr>
<td>4</td>
<td>Review specifications for support of pipe at hanger locations. Review insulation requirements at these points.</td>
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<tr>
<td>5</td>
<td>Plastic piping may sometimes require continuous support.</td>
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<tr>
<td>6</td>
<td>Review all standard requirements for quality control of specialty piping which includes keeping piping clean, properly stored (off floor) and ends capped.</td>
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<tr>
<td>7</td>
<td>Review sleeving through walls as specified by engineers. Review UL requirements as they relate to proper sleeve/piping clearances. Review all sealants including fire safing.</td>
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<tr>
<td>8</td>
<td>If piping is to be supported from open web steel joists, it must be hung from panel points, not the chords. Review any questionable installation with project manager and engineer.</td>
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<tr>
<td>9</td>
<td>If the specifications contain general statements regarding valve locations, obtain a clear agreement between engineer, Owner and mechanical contractor regarding precise locations.</td>
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<td></td>
<td>Proper access and clearances must be maintained.</td>
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<tr>
<td>10</td>
<td>Review piping insulation requirements at roof drain horizontal piping. Plus P-Sheet details.</td>
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</table>

## Medical Gas Installation

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1</td>
<td>Have pre-installation meeting with installing contractor.</td>
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<tr>
<td>2</td>
<td>All work to be in accordance with NFPA. Review foreman’s understanding of the requirements.</td>
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<tr>
<td>3</td>
<td>Check pipe and fitting storage for organization, cleanliness and end caps.</td>
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<td>4</td>
<td>Verify certification agency.</td>
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<td>5</td>
<td>Certification agency initial review during installation.</td>
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<tr>
<td>6</td>
<td>Check testing and certification procedures.</td>
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<tr>
<td>7</td>
<td>No flux is to be used during soldering.</td>
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<tr>
<td>8</td>
<td>Piping should be cleaned with nitrogen purge.</td>
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<tr>
<td>9</td>
<td>Nitrogen purge should be active during brazing operations.</td>
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<tr>
<td>10</td>
<td>Check hanger material (compatible with pipe) &amp; spacing (per NFPA 99)</td>
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<tr>
<td>11</td>
<td>Piping should be installed to eliminate contact with dissimilar material. Through stud work plastic inserts - see Specs</td>
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<tr>
<td>12</td>
<td>Piping should be cleaned prior to close up of walls.</td>
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<tr>
<td>13</td>
<td>Open end of pipe should be capped or taped closed during installation.</td>
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<tr>
<td>14</td>
<td>Piping should be labeled and color coded per specs</td>
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<tr>
<td>15</td>
<td>Valves above ceiling get special I.D.</td>
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</tbody>
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## WEEKLY QUALITY CONTROL CHECKLIST
### Division 15 – Mechanical (con’t)

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<td><strong>Equipment</strong></td>
<td></td>
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<tr>
<td>1</td>
<td>You must refer to the specifications and the manufacturer’s data for specific requirements for each item of equipment.</td>
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</tr>
<tr>
<td>2</td>
<td>Review all rigging and handling of equipment. Confirm that proper clearances are maintained during construction.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 3 | Equipment is generally set on roof curbs, steel dunnage, concrete pads or fabricated steel frames. Be sure the support is proper and correct for the equipment and its intended use.  
   - Pay attention to potential transmission of noise and vibration. Be sure proper vibration isolation equipment is provided where required. |  |
| 4 | Review flashing requirements for roof mounted equipment. |  |
| 5 | Review all anchoring requirements. |  |
| 6 | External connections, especially pipe, must be suitably and independently supported so as not to put additional unexpected stresses on the equipment. |  |
| 7 | Do not allow cutting and reworking of the prefabricated components unless reviewed with equipment manufacturer. |  |
| 8 | Be sure belt & drive guards are furnished & installed for all locations where these drive elements are exposed. Do not allow equipment to operate without proper guards. |  |
| 9 | Protect sensitive equipment from the hazards and inevitable conditions of a construction project. Temporary enclosures, protection against water may be needed. Install filters on return lines. |  |
| 10 | Check specifications and manufacturer’s literature for services required before start-up, i.e., alignment, lubrication, inspection by manufacturer’s representative. |  |
| 11 | HVAC equipment to be off during dusty work. |  |
| 12 | HVAC equipment construction operation per 15028-3.02. |  |

### Plumbing Fixtures and Equipment

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>If plumbing fixtures are delivered to jobsite for storage, inventory them for proper quantities and check for damage.</td>
<td></td>
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</tr>
<tr>
<td>2</td>
<td>Request the foreman to ensure cut outs are done with a template, if lavatories are to be mounted in vanities furnished by others.</td>
<td></td>
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<tr>
<td>3</td>
<td>Be sure roof drains are on job and ready for installation when roofing contractor is ready to begin his work.</td>
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<tr>
<td>4</td>
<td>Water closets and urinals should be installed before toilet partition.</td>
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<tr>
<td>5</td>
<td>Generally, a good installation requires wall-mounted plumbing fixtures to be caulked against the adjacent ceramic tile.</td>
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<tr>
<td>6</td>
<td>Check the ceramic tile installation after installation of plumbing fixtures; repair or replace damaged, cracked and missing tile.</td>
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<td></td>
</tr>
</tbody>
</table>

### Sheet Metal Ductwork

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
</table>
| 1 | Prior to overhead rough-in, proper coordination is required between:  
   - Ductwork,  
   - Overhead piping,  
   - Fire protection piping,  
   - Conduit, buss duct and cable trays,  
   - Lighting fixtures,  
   - Ceiling grid (where applicable), etc. |  |
| 2 | Review locations / requirements for Fire Dampers and Angle Iron Installations. |  |
| 3 | Spot check delivered sheet metal fabrications for:  
   - Gauge of metal,  
   - Reinforcing,  
   - Longitudinal seams,  
   - Transverse joint system,  
   - Proper size, |  |
<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Type, i.e. stainless steel, galvanized, other,</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>• Turning vanes, deflectors and scoops,</td>
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<tr>
<td></td>
<td>• Internal lining, where required, etc.</td>
<td></td>
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<tr>
<td>4</td>
<td>Ensure that foreman is prepared for early duct testing which will catch any upfront quality control problems. Maintain leak tests for review by engineer.</td>
<td></td>
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<tr>
<td>5</td>
<td>Duct sealants used to meet the requirements described above can, themselves, produce problems, especially in pharmaceutical installations. Be sure the sealant used meets all specification requirements.</td>
<td></td>
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</tr>
<tr>
<td>6</td>
<td>Internal lining must be adequately fastened and adhered to the sheet metal to avoid flaking, peeling and delamination due to the action of the moving air inside the duct.</td>
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</tr>
<tr>
<td>7</td>
<td>Frequently, the specifications make general statements regarding access door locations. Be sure there is a good agreement between Owner, engineer and sheet metal contractor re: number of doors. Spec. 15896, 15910, 15028.</td>
<td></td>
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<tr>
<td>8</td>
<td>Duct hangers must be adequately sized, spaced and supported. Also, check gauge of hangers. Duct must be independently supported.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Check specification requirements for protection requirements of duct when delivered and when installed. Have foreman maintain quality control for duct cleanliness and document accordingly.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Ensure that flexible duct is securely fastened with approved devices to the rigid duct and to the diffuser or other terminal device. Review specifications for allowable length of flexible duct.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Process duct, dust collection duct, fume hood exhaust duct and kitchen exhaust duct often require special fabrication, installation and testing techniques. Read the specifications carefully.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Review all duct penetration and enclosure requirements.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Keep ductwork dry during installation.</td>
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<td></td>
</tr>
</tbody>
</table>

**Insulation**

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Check the delivered materials against the approved submittals.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Review quality control of work during early stages of installation.</td>
<td></td>
<td></td>
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<tr>
<td>3</td>
<td>Check adhesives, fasteners and fastener spacing for insulation applied to sheet metal.</td>
<td></td>
<td></td>
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<tr>
<td>4</td>
<td>Piping and duct work should be tested prior to applying insulation.</td>
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<tr>
<td>5</td>
<td>Check pipe insulation at supports.</td>
<td></td>
<td></td>
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<tr>
<td>6</td>
<td>In duct has been damaged or partially collapsed for whatever reason, fix the duct before insulating. Do not allow trades to walk on duct, including the insulators.</td>
<td></td>
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<tr>
<td>7</td>
<td>Insulation exposed to the elements must have a weatherproof shield or jacket.</td>
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<tr>
<td>8</td>
<td>Check specifications to determine if any pipe or duct must be painted, coated or heat traces in the field prior to insulating.</td>
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</tbody>
</table>

**Temperature Controls**

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Be sure both the mechanical and the electrical contractors (foreman) receive copies of the approved temperature control drawings.</td>
<td></td>
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</tr>
<tr>
<td>2</td>
<td>Be sure all trades adequately respect the delicate and sensitive control tubing and instruments.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Ensure that rough-in boxes for temperature control devices are installed reasonably neat and are not subsequently abused. The finished instrument, when mounted, should be plumb and level.</td>
<td></td>
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<tr>
<td>4</td>
<td>Check thickness of recessed panels proposed by the temperature control contractor. Coordinate recesses with equipment.</td>
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<tr>
<td>5</td>
<td>Verify location of all exposed stats and sensors prior to installation.</td>
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</tr>
<tr>
<td>6</td>
<td>Compare control panels with approved data.</td>
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</tbody>
</table>
### WEEKLY QUALITY CONTROL CHECKLIST
**Division 15 – Mechanical (con’t)**

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Verify location of all control panels. Invariably panels are placed in an area that interferes with air handling access doors, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Make sure the control personnel embed the tubing or wiring in partitions during construction. All rigid conduit or EMT per 15994-2.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Ensure all automatic control services are connected. Review this in a consistent manner with the on-site foreman.</td>
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</tr>
</tbody>
</table>

#### Fire Protection

1. Verify location of incoming services.
2. Sprinkler pipe, when hung from open web steel joists, must be supported at panel points.
3. Check gauge and spacing of hangers & method of attaching hangers to overhead.
4. Check Local requirements of Licensed Fire Protection Piping Installers.
5. Verify that sprinkler pipe has been coordinated with other trades.
6. Compare type of heads with approved data, i.e., upright, semi-recessed, pendent, concealed, etc. Hang data plate on system riser.
7. Review any centering of head requirements with foreman.
8. This contractor’s calculations and drawings have to be reviewed by several parties, including FM. Ensure with foreman that all applicable reviews (Owner’s insurance company) have occurred.
9. Review all escutcheon requirements.
10. Sprinkler heads in spaces with suspended ceiling must be installed to accurate elevation.
11. Sprinkler drains passing through exterior walls should be of non-ferrous construction to avoid rust staining the wall surface.
12. Be sure adequate provisions have been made in the design for discharging test drains. Review the intent with the job foreman.
13. Make sure recessed extinguisher cabinets and hose cabinets can fit in the available wall cavity.
14. Pipe to be domestic per 15300.
15. Fire sprinklers covered with paint will be replaced.
16. Sprinkler heads in spaces with suspended ceiling must be installed to accurate elevation.
17. Review any centering of head requirements with foreman.
18. This contractor’s calculations and drawings have to be reviewed by several parties, including FM. Ensure with foreman that all applicable reviews (Owner’s insurance company) have occurred.

#### Testing and Balancing

1. Review all balancing schedule issues with testing mechanic. Request meeting of mechanical/electrical foreman with testing personnel for proper coordination.
2. Complete testing and balancing reports are required by the state agencies prior to the certificate of occupancy being issued.
3. Periodically witness the testing and balancing procedures.
4. Prior to testing and balancing, ceiling, doors, etc. should be in place.
5. Field visit plus report required per 15990
6. Test/Measure duct smoke detectors per 15990
7. Final inspection test required per 15990.
8. Replace ceiling tiles after complete with testing & balancing.

#### Yard Piping - Shop Drawing Review

1. Determine pipe & fitting classes and that purchased pipe meets the requirements
2. Coordinate pipe sizes with manhole and vault submittals
3. Review elevations of pipes at crossings and determine if a conflict exists
4. Determine if pumped lines are to be restrained or if thrust blocking is called for.
5. Review pipe encasement requirements understructures.
### WEEKLY QUALITY CONTROL CHECKLIST
**Division 15 – Mechanical (con’t)**

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Yard Piping - Fabrication, Delivery &amp; Installation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Review material needs and release pipe based on anticipated scheduled installation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Create a pipe installation log for the field demonstrating pipe bedding materials, depths, &amp; compaction requirements on backfill per specifications for each process line.</td>
<td></td>
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<tr>
<td>3</td>
<td>Create and complete pipe test log after installation (review specifications for test pressures needed)</td>
<td></td>
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<tr>
<td>4</td>
<td>Create tie-in schedule - submit on Temp. Ops as needed.</td>
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<tr>
<td>5</td>
<td>Remember confined space entry permits when applicable.</td>
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<tr>
<td></td>
<td><strong>Flanged Piping - Shop Drawing Review</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Determine pipe &amp; fitting classes and that purchased pipe meets the requirements.</td>
<td></td>
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</tr>
<tr>
<td>2</td>
<td>Coordinate with the valve shop drawings to ensure proper lay lengths are allowed for.</td>
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<tr>
<td>3</td>
<td>Review inline devices from the instrument supplier and create layout drawings with the appropriate taps included.</td>
<td></td>
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<tr>
<td>4</td>
<td>Review pipe sizes and elevations with the structural, architectural, HVAC and all other drawings to determine pipe routing conflicts.</td>
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<tr>
<td>5</td>
<td>Review all wall and slab penetrations and determine wall/floor sleeve casting requirements.</td>
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<tr>
<td>6</td>
<td>Provide floor sleeves with 2&quot; housekeeping lip, or as required by the specifications.</td>
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<tr>
<td>7</td>
<td>Review all equipment connections to verify sizing and elevations.</td>
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<tr>
<td>8</td>
<td>Determine bolt types (stainless vs. zinc plated or galvanized/grade of steel).</td>
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<tr>
<td>9</td>
<td>Build flexibility into the system - either field measure pieces of use flanged coupling adapters.</td>
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<tr>
<td>10</td>
<td>Review pipe hanger and support needs.</td>
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<tr>
<td></td>
<td><strong>Flanged Piping - Fabrication, Delivery &amp; Installation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Review material needs and release pipe based on anticipated scheduled installation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Verify that field personnel have all needed information required for proper installation</td>
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<td></td>
</tr>
<tr>
<td>3</td>
<td>Create and complete pipe test log after installation (review specifications for test pressures needed) (See Attached Example – Pg. 17-12)</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td><strong>Valves &amp; Gates - Shop Drawing Review</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Verify that all materials meet the specifications.</td>
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<tr>
<td>2</td>
<td>Review operating requirements (manual, automatic, open/close, or modulating).</td>
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<tr>
<td>3</td>
<td>Coordinate lay lengths with process mechanical drawings.</td>
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<tr>
<td>4</td>
<td>Coordinate bolt requirements as it may be different from flange piping.</td>
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<tr>
<td>5</td>
<td>Review elevation of operators and order with chain wheel if it is above specified height.</td>
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<tr>
<td>6</td>
<td>Confirm factory set points of pressure relief valves.</td>
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<tr>
<td>7</td>
<td>Determine if box outs are needed for gates &amp; coordinate with concrete pour sequence.</td>
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<tr>
<td>8</td>
<td>Verify all electrical requirements of operators and confirm with electrical one line drawings.</td>
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<tr>
<td>9</td>
<td>Send copies of shop drawings to electrician, instrumentation supplier and all other suppliers who have adjacent work. (Pumps and Equipment Manufacturers)</td>
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</tr>
<tr>
<td></td>
<td><strong>Valves &amp; Gates - Fabrication, Delivery &amp; Installation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Review material needs and release pipe based on anticipated scheduled installation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Review storage requirements and document conformance if they will be stored on site for a long duration.</td>
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<tr>
<td>3</td>
<td>Install gaskets where needed.</td>
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<tr>
<td>4</td>
<td>Have instrumentation subcontractor verify and complete a sign off on certificate of proper installation.</td>
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<tr>
<td>5</td>
<td>Verify that manufacturer representative has reviewed the installation and performed any calibrations if necessary.</td>
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<td></td>
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<tr>
<td>6</td>
<td>Schedule manufacturer rep to verify installation and sign off on completion of proper installation.</td>
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</tbody>
</table>
DIVISION 16 - ELECTRICAL
PRE-WORK MEETING – QUALITY CONTROL AGENDA

PROJECT: 

Scope of Work: ___________________________ Date: ___________________________

1. Review of Project Specifications
   a. Special Requirements
   b. Quality Control Tests Required

2. Review of Contract Documents
   a. Review all drawings for completeness and contractual responsibilities
   b. Review any coordination requirements from other trades

3. Review of Weekly Quality Control Checklist for the subcontractors scope of work

4. Procedure for Nonconforming Work

5. Material Storage Requirements

6. Subcontractor Responsibilities
   a. Quality Control – Primary responsibility is the subcontractors
   b. Requirement to report nonconforming work of the preceding contractor
   c. Review commissioning requirements
   d. Review owner training requirement

7. Sample Construction
   a. Timing
   b. Approval Process
   c. Preservation of Approved Sample

8. Protection of Completed Work and Finishes
# WEEKLY QUALITY CONTROL CHECKLIST
## Division 16 – Electrical

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Sub Initials &amp; Date</th>
<th>G.C. Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Site Electrical</strong></td>
<td></td>
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</tr>
<tr>
<td>1</td>
<td>Be familiar with the electrical incoming power requirements.</td>
<td></td>
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<tr>
<td>2</td>
<td>Review with project manager that the utility service has been ordered and that the contractor understands the service characteristics and connection point.</td>
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<tr>
<td>3</td>
<td>Review documentation relative to order for telephone service. Be sure adequate facilities are provided by contractor to receive this service.</td>
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<tr>
<td>4</td>
<td>Check location of poles, if required, under conduit, etc.</td>
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<tr>
<td>5</td>
<td>Review the proposed temporary service with the electrical contractor foreman to be sure that it is adequate for the use of all trades. Install GFCI breakers/receptacles.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Ensure location of all underground conduit has been coordinated with other underground utilities. Check for conflict with other trades with excavation &amp; check to see if utilities can be combined within a single excavation</td>
<td></td>
<td></td>
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<tr>
<td>7</td>
<td>Check size of conduits.</td>
<td></td>
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<tr>
<td>8</td>
<td>Check size, type and insulation of cable.</td>
<td></td>
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<tr>
<td>9</td>
<td>Photograph major underground installations. Coordinate with project engineer and manager.</td>
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<tr>
<td>10</td>
<td>Be sure contractor is constantly update the as-built drawings to show accurate dimensions for underground utility locations.</td>
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<tr>
<td>11</td>
<td>Check if conduit is to be encased in concrete, and if reinforcing is required. Is dye or ribbon required?</td>
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<tr>
<td></td>
<td><strong>Interior Electrical</strong></td>
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</tr>
<tr>
<td>1</td>
<td>Inspect all equipment deliveries for damage.</td>
<td></td>
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<tr>
<td>2</td>
<td>Compare equipment with approved data.</td>
<td></td>
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<tr>
<td>3</td>
<td>Observe the contractors handling and storage of the materials to be sure it is proper.</td>
<td></td>
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<tr>
<td>4</td>
<td>Check for adequate protection of equipment which includes moisture, humidity and dust control.</td>
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<tr>
<td>5</td>
<td>Check type and gauge of hangers.</td>
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</tr>
<tr>
<td>6</td>
<td>Check method of hanger connections to overhead.</td>
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<tr>
<td>7</td>
<td>On major switchgear, be sure temporary heaters are wired and energized.</td>
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<tr>
<td>8</td>
<td>Verify that the overhead work has been coordinated with other trades.</td>
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<tr>
<td>9</td>
<td>Review the temporary electrical requirements and distribution.</td>
<td></td>
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<tr>
<td>10</td>
<td>Review the height requirements of all electrical outlets and devices.</td>
<td></td>
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<tr>
<td>11</td>
<td>Compare catalog number with approved shop drawings for light fixtures.</td>
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<tr>
<td>12</td>
<td>Fixture type/appropriate for ceiling lay-in, plaster, concrete, etc.</td>
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<tr>
<td>13</td>
<td>Check that ballasts are correct voltage and specified type.</td>
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<tr>
<td>14</td>
<td>Confirm lamp type and catalog number (special lamps required for some ballasts for light fixtures.</td>
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<tr>
<td>15</td>
<td>Panel sized depths in partitions. Ensure electrical foreman coordinates properly.</td>
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<tr>
<td>16</td>
<td>Ensure that in-slab conduit is suitable (no aluminum or EMT) expansion fittings as required - ends capped. Special conduit and fittings are required in embedded installations.</td>
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<td>17</td>
<td>Verify that stub-up locations are correctly placed and supported prior to pour.</td>
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<tr>
<td>18</td>
<td>Through-slab sleeves in place for risers. Confirm with foreman that all firesafing is being coordinated.</td>
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<tr>
<td>19</td>
<td>Equipment grounding conductors in place and correctly sized.</td>
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<tr>
<td>20</td>
<td>Check stub-outs for connection to exterior grounding grid.</td>
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<tr>
<td>21</td>
<td>Color identification for conduits of different building systems. Junction boxes identified.</td>
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<tr>
<td>22</td>
<td>Wire identification markers.</td>
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<td>23</td>
<td>Check Firestopping Requirements. Whose contract is it in?</td>
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<td>24</td>
<td>Check feeder cables for correct size and type.</td>
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<tr>
<td>25</td>
<td>Ensure that code required clearances are maintained for electrical equipment.</td>
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## WEEKLY QUALITY CONTROL CHECKLIST

**Division 16 – Electrical (con’t)**

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
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<th>G.C. Initials &amp; Date</th>
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| 26  | Rough-in:  
- Check contractors stub-up locations.  
- Check tie down of conduits in scabs to protect door from floating and moving.  
- Check pads against approved shop drawings.  
- Coordinate equipment locations to maintain proper door swing and working clearances.  
- Grounding system conductors placed before pour.  
- Empty conduits to be capped and protected.  
- Ensure electrical foreman provides panel schedules in a timely manner. | | |

### Instrumentation & Controls

1. Review in-line equipment  
2. Review calibration and alarm settings  
3. Review Loop Drawings  
4. Review all other shop drawings

### Shop Drawing Review

1. Copy the electrician on all materials which require electric.  
2. Have the electrician respond in writing on any electrical issues.  
3. Determine the need to have an independent party review the electrical documents/submittals for verification of compatibility.

### Fabrication, Delivery & Installation

1. Get a conduit layout drawing to coordinate embeds.  
2. Have electrician sign off on all equipment connections prior to start-up of equipment.  
3. Have electrician present on site at the start-up of all equipment.  
4. Have the electrician present at all job site meetings.  
5. Have weekly coordination meetings with the electrician.
FIRST WORK INSPECTION CHECKLIST
* Attach additional sheets if necessary

Project No: ___________________________  Date: ___________________________

Project Title: _____________________________________________________________

Description of Work/Spec #: _______________________________________________

Personnel Present

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<tr>
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<th>Name</th>
<th>Position</th>
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Identify Full Compliance with Plans, Specifications & Submittals

Does material/equipment match plans and specs?  Yes [ ]  No [ ]

Does material/equipment match approved submittal?  Yes [ ]  No [ ]

Comments: ______________________________________________________________

________________________________

Establish Level of Workmanship

Where is first work located? _______________________________________________

Is sample panel required?  Yes [ ]  No [ ]

Will first work be considered sample?  Yes [ ]  No [ ]

Comments: ______________________________________________________________

________________________________

Check Safety

Are there any safety concerns or hazards associated with this type of work? Comment below.

________________________________

________________________________

________________________________

ONSITE QC MANAGER ___________________________  DATE ___________________________
## FIRST WORK INSPECTION CHECKLIST LOG

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# MATERIAL EXPEDITING LOG

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# ABOVE CEILING PUNCHLIST

**Project:**

**Date:**

**Room #**

**Bldg/Flr:**

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**BELOW CEILING PUNCHLIST**

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<th>PAINT &amp; VINYL WALL COVERING</th>
<th>CASEWORK &amp; MILLWORK</th>
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<tr>
<td>Adjust Closer</td>
<td>Repair Damage in VWC @ N E S W Wall</td>
<td>Adjust Door @</td>
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<tr>
<td>Adjust Strike Plate</td>
<td>Repair Damage in Paint @ N E S W Wall</td>
<td>Adjust Drawer @</td>
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<tr>
<td>Adjust Lock Strike to Latch</td>
<td>Touch Up Paint @ N E S W Wall</td>
<td>Caulk backsplash to counter</td>
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<tr>
<td>Repair Damaged Door</td>
<td>Touch Up Paint on Door &amp; Frame</td>
<td>Caulk</td>
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<tr>
<td>Install Silencers at Frame</td>
<td>Remove Paint @</td>
<td>Repair chipped laminate @</td>
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<td>Repair Touchup Paint in Hollow Metal Frame</td>
<td>Clean VWC Glue from</td>
<td>Repair Damaged Laminate @</td>
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<td>Install Lock Cylinders</td>
<td>Finish Final Painting</td>
<td>Seam Fill &amp; Repair Seam in Countertop</td>
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<td>Install door wall stop</td>
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<td>Adjust door margins</td>
<td>Caulk Hollow Metal Door Frame</td>
<td>Adjust diffuser to finished ceiling</td>
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<td>Adjust /tighten loose door hardware</td>
<td>Caulk Door Frame to Floor</td>
<td>Label Damper Access Door on Ceiling Grid</td>
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<td>Check lock functions</td>
<td>Caulk window sill</td>
<td>Clean Return Air Grille</td>
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<td>Caulk window jambs and header</td>
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<td>Caulk water closet to floor and wall</td>
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</tbody>
</table>
# CONCRETE PLACEMENT CHECKLIST

<table>
<thead>
<tr>
<th>Project</th>
<th>Subcontractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Placement Number</td>
<td>Date of Placement</td>
</tr>
<tr>
<td>Start Time</td>
<td>Finish Time</td>
</tr>
<tr>
<td>Drawing</td>
<td>Specification</td>
</tr>
<tr>
<td>Strength of Mix</td>
<td>Mix Design No.</td>
</tr>
<tr>
<td># of Cylinder Req.</td>
<td>Type of Curing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Required</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cubic Yardage (CY)</td>
<td></td>
</tr>
<tr>
<td>Air Temperature</td>
<td></td>
</tr>
<tr>
<td>Temperature of Concrete</td>
<td></td>
</tr>
<tr>
<td>Slump</td>
<td></td>
</tr>
</tbody>
</table>

**Items to be Placed, Description and Location:**

1.

2.

3.

**Pre-Placement Approvals**

The following items shall be initialed by the appropriate **subcontractor** prior to the placement of concrete.

<table>
<thead>
<tr>
<th>Item</th>
<th>Initial</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EXCAVATION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excavation location (survey check)</td>
<td>Size and spacing in compliance</td>
<td></td>
</tr>
<tr>
<td>Subgrade location (survey check)</td>
<td>Splices in compliance</td>
<td></td>
</tr>
<tr>
<td>Screed rail elevation (survey check)</td>
<td>Anchor bolt location checked</td>
<td></td>
</tr>
<tr>
<td>Soil bearing capacity (3rd party)</td>
<td><strong>MECHANICAL</strong></td>
<td></td>
</tr>
<tr>
<td><strong>FORMWORK</strong></td>
<td>Embedments set</td>
<td></td>
</tr>
<tr>
<td>Line and grade verified</td>
<td>Piping complete</td>
<td></td>
</tr>
<tr>
<td>Adequate ties and bracing</td>
<td><strong>ELECTRICAL</strong></td>
<td></td>
</tr>
<tr>
<td>Blockouts in place</td>
<td>Embedments set</td>
<td></td>
</tr>
<tr>
<td>Exp. joints and waterstop in place</td>
<td>Conduit complete</td>
<td></td>
</tr>
<tr>
<td>Chamfer strips in place</td>
<td>Grounding complete</td>
<td></td>
</tr>
<tr>
<td>Form surfaces in good condition</td>
<td><strong>Remarks</strong></td>
<td></td>
</tr>
<tr>
<td><strong>CLEANLINESS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All debris removed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dewatering complete</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks**

<table>
<thead>
<tr>
<th>Third Party Insp.</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>G.C. Rep.</td>
<td>Date</td>
</tr>
</tbody>
</table>

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Page 17-8
Quality Control Manual
January 1, 2009
# DAILY QUALITY CONTROL REPORT

(ATTACH ADDITIONAL SHEETS IF NECESSARY)

<table>
<thead>
<tr>
<th>PHASE</th>
<th>PROJECT NO.</th>
<th>PROJECT TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE-WORK</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>WERE ANY PRE-WORK MTGS. HELD TODAY?</td>
<td>YES ☐</td>
</tr>
<tr>
<td></td>
<td>Spec. Section / Contractor</td>
<td>Description of Work</td>
</tr>
<tr>
<td></td>
<td>Were Any Pre-Work Mtgs. Held Today?</td>
<td>YES ☐</td>
</tr>
<tr>
<td></td>
<td>If Yes, Fill Out and Attach Minutes from Mtg.</td>
<td></td>
</tr>
<tr>
<td>FIRST-WORK</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>WERE ANY FIRST-WORK INSPECTIONS PERFORMED TODAY?</td>
<td>YES ☐</td>
</tr>
<tr>
<td></td>
<td>Spec. Section / Contractor</td>
<td>Description of Work</td>
</tr>
<tr>
<td></td>
<td>Were Any First-Work Inspections Performed Today?</td>
<td>YES ☐</td>
</tr>
<tr>
<td></td>
<td>If Yes, Fill Out and Attach First Work Inspection Checklist.</td>
<td></td>
</tr>
<tr>
<td>DAILY FOLLOW-UP INSPECTIONS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spec. Section / Contractor</td>
<td>Location</td>
</tr>
<tr>
<td>DAILY FOLLOW-UP INSPECTIONS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>REWORK ITEMS IDENTIFIED TODAY (NOT CORRECTED BY CLOSE OF BUSINESS)</td>
<td>REWORK ITEMS CORRECTED TODAY (FROM REWORK ITEMS LIST)</td>
<td></td>
</tr>
<tr>
<td>Spec. Section / Contractor</td>
<td>Description</td>
<td>Spec. Section / Contractor</td>
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<td>Spec. Section / Contractor</td>
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<tr>
<td>Spec. Section / Contractor</td>
<td>Description</td>
<td>Spec. Section / Contractor</td>
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</tbody>
</table>

REMARKS (Explain Any Safety Concerns or Other Issues Noted Above)

Spec. Section / Contractor | Description
Spec. Section / Contractor | Description
Spec. Section / Contractor | Description
Spec. Section / Contractor | Description

Onsite QC Manager | Date
### EXTERIOR SKIN QC & SPECIAL INSPECTION CHECKLIST

<table>
<thead>
<tr>
<th>Project</th>
<th>Elevation (N, S, E, W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subcontractor</td>
<td>Location (Col. lines)</td>
</tr>
<tr>
<td>Date</td>
<td>Floor (Ground, 2nd, etc.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ITEM</th>
<th>INITIAL</th>
<th>DATE</th>
<th>COMMENTS</th>
</tr>
</thead>
</table>

#### EXTERIOR STUDS / SHEATHING (PRE-TYVEK)

<table>
<thead>
<tr>
<th>METAL STUDS</th>
<th>INITIAL</th>
<th>DATE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check Gauge of Studs/Track (per approved shop drawings)</td>
<td></td>
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<tr>
<td>Caulk Under Track</td>
<td></td>
<td></td>
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<tr>
<td>Check Stud Spacing</td>
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<tr>
<td>Check Screws - Type, Size, Spacing</td>
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</table>

#### DENSGLASS

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<thead>
<tr>
<th>INITIAL</th>
<th>DATE</th>
<th>COMMENTS</th>
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</thead>
<tbody>
<tr>
<td>Board is Dry &amp; in Good Condition</td>
<td></td>
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<tr>
<td>Screw Spacing – Type, S12, Spacing</td>
<td></td>
<td></td>
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<tr>
<td>Caulk at Joints and Perimeter</td>
<td></td>
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<tr>
<td>Tape at Joints and Screw Heads</td>
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#### TYVEK INSPECTION

<table>
<thead>
<tr>
<th>INITIAL</th>
<th>DATE</th>
<th>COMMENTS</th>
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</thead>
<tbody>
<tr>
<td>Correct screws &amp; neoprene washers</td>
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<tr>
<td>Screw spacing</td>
<td></td>
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<tr>
<td>All joints taped and/or caulked</td>
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</table>

#### WINDOW OPENINGS – Verify with Shop Drawings

<table>
<thead>
<tr>
<th>INITIAL</th>
<th>DATE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width - ok</td>
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<tr>
<td>Height - ok</td>
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#### LOUVER OPENINGS – Verify with Shop Drawings

<table>
<thead>
<tr>
<th>INITIAL</th>
<th>DATE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width - ok</td>
<td></td>
<td></td>
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<tr>
<td>Height - ok</td>
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#### OTHER OPENINGS SHOWN?

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<thead>
<tr>
<th>INITIAL</th>
<th>DATE</th>
<th>COMMENTS</th>
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</thead>
<tbody>
<tr>
<td>Overflow Spouts, Electrical Penetrations</td>
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#### CONTROL JOINTS

<table>
<thead>
<tr>
<th>INITIAL</th>
<th>DATE</th>
<th>COMMENTS</th>
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<tbody>
<tr>
<td>Review CJ Requirements For Each Area</td>
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</table>

#### CMU -- GROUT / MORTAR / REINFORCING

<table>
<thead>
<tr>
<th>INITIAL</th>
<th>DATE</th>
<th>COMMENTS</th>
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</thead>
<tbody>
<tr>
<td>Three (3) CMU Tested per spec</td>
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<tr>
<td>Mortar - Prism Test or Cube Test - see spec</td>
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<td></td>
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<tr>
<td>Coarse Grout - Prism Test or Cube Test - see spec</td>
<td></td>
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<tr>
<td>Cleanliness of Grout Space Prior to Grouting</td>
<td></td>
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<tr>
<td>Check Reinforcing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check Type, Size and Location of Anchors</td>
<td></td>
<td></td>
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<tr>
<td>Check Proportions of Site-Prepared Mortar or Grout</td>
<td></td>
<td></td>
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</table>

#### FLASHING INSPECTION

<table>
<thead>
<tr>
<th>INITIAL</th>
<th>DATE</th>
<th>COMMENTS</th>
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</thead>
<tbody>
<tr>
<td>Check Window Head Flashing</td>
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<tr>
<td>Check flashing at Other Brick Ledge Angles</td>
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<tr>
<td>Check Termination Bar/Sealant</td>
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#### REMARKS

<table>
<thead>
<tr>
<th>INITIAL</th>
<th>DATE</th>
<th>COMMENTS</th>
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</thead>
<tbody>
<tr>
<td>Indep. Testing Lab.</td>
<td></td>
<td></td>
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<tr>
<td>Masonry Sub Rep.</td>
<td></td>
<td></td>
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<tr>
<td>Exterior Studs Sub Rep.</td>
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</tbody>
</table>
FUNCTIONAL ACCEPTANCE TEST

Project:  
Contract:  
Equipment:  
Manufacturer:  
Model No.:  
Serial No.:  
Equipment ID:  
General Contractor:  
Installation Contractor:  
Test Date:  
Misc. Test Notes:  

In accordance with Specification ______, I hereby, as the authorized manufacturer’s representative, certify that the above piece of equipment has been tested and performs to the standards as outlined in the following except from the equipment’s specification section.

<table>
<thead>
<tr>
<th>Specification Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Article</td>
<td></td>
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<tr>
<td>Comments:</td>
<td></td>
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</tbody>
</table>

Inspector: ________________________________  (Signature)  (Print)  (Date)

Contractor: ________________________________  (Signature)  (Print)  (Date)

Engineer: ________________________________  (Signature)  (Print)  (Date)
# PIPE TEST REPORT

<table>
<thead>
<tr>
<th>Line Service</th>
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</thead>
<tbody>
<tr>
<td>Test Attempt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipe Material (DI, RCP, PVC, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal Operating Pressure</td>
<td>Specified</td>
<td>Actual</td>
</tr>
<tr>
<td>Testing Methods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test Pressures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test Duration</td>
<td></td>
<td></td>
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<tr>
<td>Allowable Loss/ Pressure Drop</td>
<td></td>
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<tr>
<td>Remarks:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Test Performed by: ____________________________ (Signature) ____________________________ (Print) ____________________________ (Date)

Test Witnessed by: ____________________________ (Signature) ____________________________ (Print) ____________________________ (Date)

Test Accepted: ____________________________ Test Rejected: ____________________________
## SPARE PARTS TRANSFER FORM

<table>
<thead>
<tr>
<th>Spec No.</th>
<th>Quantity</th>
<th>Part No.</th>
<th>Manufacturer &amp; Item Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td></td>
</tr>
<tr>
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Delivered By: __________________________________________________________________________ Date: __________

Witnessed By: _________________________________________________________________________ Date: __________

The above-listed spare parts & MSDS Sheets have been inspected and inventoried and are hereby accepted, subject to all Contract Provisions, by the Owner.

Received

Owner Representative __________________________________________________________________________ Date: __________
<table>
<thead>
<tr>
<th>Project:</th>
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<tbody>
<tr>
<td>Equipment:</td>
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<td>Specification Section:</td>
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<td>Contract:</td>
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I hereby certify the equipment supplier/manufacturer has instructed OWNER’S personnel in the startup, operation, and maintenance of this equipment as required in the Specifications.

**CONTRACTOR**

<table>
<thead>
<tr>
<th>Signature</th>
<th>Date:</th>
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<th>Title</th>
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I hereby certify that my operating personnel received _____ days (or hours) of Start-Up & Instruction on _____ for startup, operation, and maintenance of this equipment.

Have the Operation & Maintenance Manuals been received? Yes [ ] No [ ]

If not, explain below in comments section.

**OWNER**

<table>
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Comments:

**ATTENDEES**

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</table>
January 31, 2017

Levin Porter Associates, Inc.
3011 Newmark Drive
Miamisburg, Ohio 45342

Attention: Mr. Matt Franklin, AIA, Vice President
Email: mfranklin@levin-porter.com

Re: Geotechnical Exploration Report
Dayton Metro Library Segment 3 – Southeast Branch
Wayne Avenue and Watervliet Avenue
Dayton, Ohio 45420
PSI Project No. 01051073

Dear Mr. Franklin:

Thank you for choosing Professional Service Industries, Inc. (PSI) as your consultant for the Dayton Metro Library Segment 3 - Southeast Branch to be located near the intersection of Wayne Avenue and Watervliet Avenue in Dayton, Ohio. Per your authorization, PSI has completed a geotechnical engineering study for the referenced project. The results of the study are discussed in the accompanying report, one (1) copy of which is enclosed.

It is considered imperative that the Geotechnical Engineer and/or their representative be present during earthwork operations, foundations and floor slab installations to observe the field conditions with respect to the design assumptions and specifications. PSI will not be held responsible for interpretations and field quality control observations made by others.

If you have any questions pertaining to this report, please contact our office at (937) 898-1200. PSI would be pleased to continue providing geotechnical services throughout the implementation of the project, and we look forward to working with you and your organization on this and future projects.

Respectfully submitted,
PROFESSIONAL SERVICE INDUSTRIES, INC.

R. Andrew Schlarman II, P.E.
Branch Manager

Ralph M. O'Quinn, P.E.
Chief Engineer/Principal Consultant

Enclosures
Geotechnical Exploration Report

of

DML Segment 3 – Southeast Branch
Wayne Avenue and Watervliet Avenue
Dayton, Ohio 45420

Prepared for

Levin Porter Associates, Inc.
3011 Newmark Drive
Miamisburg, Ohio 45342

Prepared by

Professional Service Industries, Inc.
5599 Webster Street
Dayton, OH 45414

Report Date: January 31, 2017

PSI Project No. 01051073
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  Seismic Output
  General Notes
  Unified Soil Classification System (USCS)
PROJECT INFORMATION

Project Authorization

The following Table summarizes (in chronological order) the Project Authorization History for the services performed and represented in this report by Professional Service Industries, Inc. (PSI):

<table>
<thead>
<tr>
<th>PROJECT TITLE: DML SEGMENT 3 – SOUTHEAST BRANCH LIBRARY</th>
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<tbody>
<tr>
<td>Document and Reference Number</td>
</tr>
<tr>
<td>Request for Proposal</td>
</tr>
<tr>
<td>PSI Proposal Number: 0105-189871</td>
</tr>
<tr>
<td>Signed Authorization – PSI Proposal</td>
</tr>
</tbody>
</table>

Project Description

PSI received/obtained the following documents to aid in preparing this report:

- An e-mail from Ms. Debbie Gibson on behalf of Mr. John Fabelo, AIA of Dayton Design Collaborative LLC dated September 7, 2016
- Written Request for Proposal titled, “RFP for Dayton Metro Library—Subsurface Investigation, Special Material Testing, and Hazardous Material Testing Services for Segment 3, DDC Project No. 16100.00 (9 pages) from Mr. John Fabelo outlining scope of work.
- An email from Ms. Janna Hill, Associate, of Levin Porter Associates, Inc. dated December 8, 2016 requesting a proposal.
- An untitled, undated drawing showing the layout of the proposed library and soil test boring locations.

PSI understands Levin Porter Associates, Inc. is currently developing information regarding the proposed Dayton Metro Library Segment 3 - Southeast Branch to be located near the intersection of Wayne Avenue and Watervliet Avenue in Dayton, Ohio. The proposed Southeast Branch building will reportedly consist of a single-story, steel-framed structure with a concrete slab-on-grade floor measuring approximately 24,000 square feet in plan area. Additionally, there will be parking spaces to the south of the proposed building and an entrance from Watervliet Avenue.

No loading information was provided at the time of this report. However, it is anticipated that the column and wall loads will not exceed about 100 kips, and 3 kips per lineal foot, respectively and that the slab-on-grade loading will not exceed about 150 pounds per square foot. No topographical information was available at the time of this report. However, based on our site visit, PSI estimates that the maximum cut/fill for the building and parking areas will be approximately 2 feet. No other information relative to the spatial geometry or other aspects of the project is available at this time.

The geotechnical recommendations presented in this report are based on the available project information, building location and the subsurface materials described in this report. If any of the
information noted above is incorrect, please inform PSI in writing so that we may amend the recommendations presented in this report if necessary. PSI will not be responsible for the implementation of its recommendations when it is not notified of changes in the project.

Purpose and Scope of Services

The purpose of this study was to explore the subsurface conditions at the site to prepare recommendations for foundation systems for the proposed building and design parameters for the pavement areas. PSI’s contracted scope of services included drilling eight (8) soil test borings including six (6) borings in the proposed building footprint to depths of 25 feet each and two (2) borings in the pavement areas drilled to depths of 10 feet each below the existing surface grades, a select laboratory testing program, and preparation of this geotechnical report. This report briefly outlines the testing procedures, presents available project information, describes the site and subsurface conditions, and presents recommendations regarding the following:

- A general assessment of area geology based on our local knowledge and study of available geological literature
- Foundation system evaluations and the assessment of the feasibility of utilizing shallow foundations
- Design parameters required for the foundation system, including allowable bearing pressure, minimum foundation width, foundation bearing levels, and estimated total and differential settlements
- Design parameters required for the below-grade walls, including coefficients of active, passive and at-rest pressure
- Site preparation as needed for support of foundations and slabs
- General location, description of materials encountered in the borings which may interfere with construction progress or structure performance, including existing fills, cobbles/boulders, or organic soils
- Identification of water levels encountered at the time of drilling
- Recommendation of modulus of subgrade reaction, and analysis of the swell potential of surface soil based on index tests
- Recommendations for fill including the selection of materials for use and procedures for placement
- Recommendations for pavement thickness based on client provided design traffic
- Construction considerations, including temporary excavation and construction control of water.
- Seismic Site Class.

The scope of services did not include an environmental assessment for determining the presence or absence of wetlands, or hazardous or toxic materials in the soil, bedrock, surface water, groundwater, or air on, below, or around this site. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes. Prior to further development of this site, an environmental assessment is advisable.

PSI’s scope also did not provide any service to investigate or detect the presence of moisture, mold or other biological contaminants in or around any structure, or any service that was designed or intended to prevent or lower the risk of the occurrence or the amplification of the same. The client should be aware that mold is ubiquitous to the environment with mold amplification occurring when building materials are impacted by moisture. The client should be aware that site conditions are outside of PSI’s control, and that mold amplification will likely occur, or continue to occur, in the

Levin Porter Associates, Inc.  
Proposed DML Segment 3 – Southeast Branch, Dayton, Ohio

Professional Service Industries, Inc.  
PSI Project Number 01051073
presence of moisture. As such, PSI cannot and shall not be held responsible for the occurrence or reoccurrence of mold amplification.

SITE AND SUBSURFACE CONDITIONS

Site Location and Description
The project site for the proposed Southeast Branch Library is located on the southwest corner of the intersection of Wayne Avenue and Watervliet Avenue in Dayton, Ohio. The site latitude and longitude is approximately N 39.7386° and W -84.1526°, respectively.

At the time of our site reconnaissance, the proposed site consisted of a baseball/softball field for Belmont High School and was covered with topsoil, grass, weeds and asphalt. PSI noted tree lines to the north and east of the baseball field during our site visit. Based on a Google Earth™ history search, it appears that the site was developed sometime in 2010 during construction of Belmont High School.

The site is currently bordered by another baseball/softball field to the south, the City of Dayton Fire Station 15 to the west, Wayne Avenue to the north and Watervliet Avenue/residential properties to the east. The maximum elevation variance within the development appeared to be less than 2 feet.

Site Geology
Based on the on-line geologic map provided by the Ohio Geological Survey (available at http://www.dnr.state.oh.us/OhioGeologicalSurvey/SurficialGeology/tabid/23586/Default.aspx), the proposed site area is located in the Central Lowland Province, Till Plains Section, Southern Ohio Loamy Till Plains region, with ground moraine and outwash topography supported by Silurian bedrock as part of the Wisconsinan Glacial Period.

Subsurface Conditions
Eight (8) soil test borings including six (6) borings within the proposed building footprint drilled to depths of about 25 feet each and two (2) borings in the pavement areas drilled to depth of 10 feet each below existing surface grades were performed. The boring locations and depths were suggested by PSI and reviewed by the client prior to drilling. PSI personnel staked the borings in the field by utilizing a handheld GPS unit. The surface elevations of the borings should be surveyed prior to construction activities.

The borings were advanced utilizing 2½ inch inside diameter, hollow-stem auger drilling methods. Soil samples were routinely obtained during the drilling process. Select soil samples were later tested in the laboratory to obtain soil material properties for the foundation, and concrete slab on grade recommendations. Drilling, sampling, and laboratory testing was accomplished in general accordance with ASTM procedures.

The surface materials at the soil test boring locations consisted of topsoil having a thickness of about 4 inches. The surficial material thicknesses should be expected to be widely variable throughout the proposed development.

Beneath the surface materials at test boring location B-4, undocumented fill consisting of Sandy Lean Clay (CL) was encountered. The undocumented fill at soil boring B-4 extended to a depth of about 3 feet below existing surface grades. The engineering characteristics of the undocumented fill such as strength and compressibility will likely be variable. The fill thicknesses should be expected to be widely variable and, based on the previous development of the site,
should be expected to be encountered in other areas beyond the soil boring locations and possibly to greater depths than encountered in the soil test borings.

Beneath the undocumented fill at B-4 and surface materials at the remaining soil test borings, natural soils consisting of Lean Clay (CL) with variable fractions of sand and gravel, Well Graded Sand with Clay and Gravel (SW-SC), Clayey Sand (SC) with gravel and Poorly Graded Sand were encountered. The natural soils extended to depths ranging from 10 to 25 feet below existing surface grades. The natural soils had SPT blows (N₆₀) values ranging from 6 blows per foot (bpf) to 50 blows per 1 inch of penetration and moisture contents of 2 to 23 percent.

The following table briefly summarizes the range of results from the field and laboratory testing programs. Please refer to the attached boring logs and laboratory data sheets for more specific information:

### Table 1
**Summary of SPT N Values, Moisture Content & Ground Water Levels**

<table>
<thead>
<tr>
<th>Top of Soil Sampling Depth (ft)</th>
<th>SPT N Values (Blows/ft)</th>
<th>Moisture Content (%)</th>
<th>Groundwater Level Readings and Borehole Caving Depth (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B-1</td>
<td>B-2</td>
<td>B-3</td>
</tr>
<tr>
<td>1.0</td>
<td>17</td>
<td>13</td>
<td>11</td>
</tr>
<tr>
<td>3.5</td>
<td>34</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>6.0</td>
<td>30</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>8.5</td>
<td>31</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>13.5</td>
<td>41</td>
<td>37</td>
<td>37</td>
</tr>
<tr>
<td>18.5</td>
<td>98</td>
<td>100</td>
<td>38</td>
</tr>
<tr>
<td>23.5</td>
<td>100</td>
<td>62</td>
<td>100</td>
</tr>
</tbody>
</table>

- **Water Level Encountered While Drilling**: NE - Not Encountered
- **Water Level Reading Encountered Upon Completion**: NE - Not Encountered
- **Boring Cave Depth Upon Completion**: 14.0 | 16.0 | 15.0 | 14.0 | 13.0 | 13.5 | 7.0 | 8.0 | -
Laboratory Testing

Laboratory index testing was conducted on samples obtained during field drilling operations. The results are listed in Table 2 and Table 3 below.

### Table 2
**Soil Index Tests**

<table>
<thead>
<tr>
<th>Boring No</th>
<th>Sample Depth</th>
<th>Liquid Limit</th>
<th>Plastic Limit</th>
<th>Plasticity Index</th>
<th>Moisture Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
<td>6 to 7-1/2</td>
<td>44</td>
<td>20</td>
<td>24</td>
<td>18</td>
</tr>
<tr>
<td>B-3</td>
<td>1 to 2-1/2</td>
<td>35</td>
<td>17</td>
<td>18</td>
<td>23</td>
</tr>
<tr>
<td>B-8</td>
<td>3-1/2 to 5</td>
<td>45</td>
<td>20</td>
<td>25</td>
<td>21</td>
</tr>
</tbody>
</table>

### Table 3
**Soil Grain Size Analysis**

<table>
<thead>
<tr>
<th>Boring No</th>
<th>Sample Depth</th>
<th>Gravel %</th>
<th>Sand %</th>
<th>Silt and Clay %</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
<td>6 to 7-1/2</td>
<td>0.8</td>
<td>42.4</td>
<td>56.8</td>
</tr>
<tr>
<td>B-3</td>
<td>1 to 2-1/2</td>
<td>24.6</td>
<td>32.2</td>
<td>43.2</td>
</tr>
<tr>
<td>B-4</td>
<td>18-1/2 to 20</td>
<td>34.9</td>
<td>53.1</td>
<td>12.0</td>
</tr>
<tr>
<td>B-6</td>
<td>8-1/2 to 10</td>
<td>0.0</td>
<td>72.7</td>
<td>27.3</td>
</tr>
<tr>
<td>B-8</td>
<td>3-1/2 to 5</td>
<td>0.7</td>
<td>38.2</td>
<td>61.1</td>
</tr>
</tbody>
</table>

The above subsurface description is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The boring logs included in the Appendix should be reviewed for specific information at individual boring locations. These records include soil/rock descriptions, stratifications, penetration resistances, and locations of the samples and laboratory test data. The stratifications shown on the boring logs represent the conditions only at the actual boring locations. Variations may occur and should be expected between boring locations. The stratifications represent the approximate boundary between subsurface materials and the actual transition may be gradual. Water level information obtained during field operations is also shown on these boring logs. The samples that were not altered by laboratory testing will be retained for sixty (60) days from the date of this report and then will be discarded.

**Groundwater Level Measurements**

Groundwater was not encountered during or upon completion of drilling operations. However, it must be recognized that free groundwater levels can significantly fluctuate (seasonally) and as a function of rainfall. During a time of year or weather different from the time of drilling, there may be a considerable change in the water table or the occurrence of water where not previously encountered. Furthermore, the free groundwater levels in the boreholes often are not representative of the actual groundwater level, because the boreholes remain open for a relatively short time. To obtain longer-term measurements, it is necessary to install water level observation wells or piezometers. The water level measurements presented in this report are the levels that were measured at the time of PSI’s field activities. Therefore, we recommend that the contractor determine the actual groundwater levels at the time of construction to evaluate groundwater impact on the construction procedures.
GEOTECHNICAL EVALUATION

There are two (2) geotechnical-related issues at this site which will affect design and performance of the structure. The following summarizes these concerns:

1. **Undocumented fill was encountered at soil test boring B-4 to a depth of about 3 feet below existing surface grades.** It should be anticipated that undocumented fill will be encountered in other areas of the site and to greater depths than encountered in the soil test borings. All footings should be placed to bear on native, undisturbed soil or compacted and tested fill material. The *Site Preparation* section of this report must be followed.

2. **If necessary, aeration and drying of some of the wetter on-site natural soils may be required during site grading and compacting operations.** Reducing the moisture content of the clay/silt soils may be necessary to achieve proper compaction and establish stable subgrade conditions.

**Undocumented Fill Materials**

The presence of existing undocumented fill introduces a design and construction risk due to the potential for excessive and/or non-uniform settlement. To reduce the settlement risk, PSI recommends that the undocumented fill be removed and replaced with compacted and tested structural fill or the building foundations extend through the fill to natural material. The foundation excavations can be extended to firm natural soil or structural fill (or lean concrete monoliths) can be placed to footing grade. The *in-situ lean sandy lean clay and clayey sand soils can be re-compacted as engineered fill, provided it is free of any organic or other deleterious material*. Structural fill should meet the requirements and be prepared as recommended in the *Site Preparation* Section of this Report. Considering construction has occurred on and nearby the site, it is possible that areas of additional fill and/or buried construction debris deposits that were not identified by the boring program could be encountered at this site. The fill material may also extend to greater depths than observed in the soil test borings.

**Soil Compaction**

Since this site contains some fine-grained clay soils, during periods of wet weather or decreased drying time (such as spring, fall, and winter) it may become difficult to achieve the desired compaction of the soils due to high moisture contents. The soils may need to be scarified and dried to a moisture content that will facilitate compaction in accordance with the structural fill requirements of this report. Use of geofabric and/or geogrid reinforcement or lime, kiln dust, or fly ash stabilization may be necessary to expedite the work and achieve the required level of soil compaction.

**GEOTECHNICAL RECOMMENDATIONS**

The following geotechnical related recommendations have been developed based on the subsurface conditions encountered and PSI’s understanding of the proposed development. Should changes in the project criteria occur, a review must be made by PSI to determine if modifications to our recommendations will be required.

**Site Preparation**

Prior to placing concrete floors, pavements or engineered fill on this site, general site area clearing should be carried out. All existing topsoil, excessively wet soils, highly organic soils, and soft/loose or obviously compressible materials, should be completely removed from the proposed construction
areas. Additionally, undocumented fill soils were encountered in soil test boring B-4. The most positive method of supporting the structure is to remove the undocumented fill material and replace it with compacted and tested structural fill or extend the foundations through the undocumented fill to native soil. It appears that the undocumented fill material encountered in the boring program can be used as structural fill after moisture conditioning and re-compacting and provided the soils meet the structural fill requirements outlined in this report. Undocumented fill soils (if encountered) should be removed a minimum of 12 inches below bottom of floor slab and pavement elevations and 24 inches below foundation elevations and replaced with compacted and tested structural fill.

Remnants of former structures, if encountered, should also be completely removed, including the foundation system. All excavations created during the removal process should be backfilled with compacted and tested structural fill. The decision about the precise extent of required undocumented fill removal should be determined in the field by a representative of PSI following observation of the exposed subgrades and proof rolling operations.

In this region, these otherwise competent lean clays can undergo a significant loss of stability when construction activities are performed during wetter portions of the year. PSI anticipates that the soils in the project area can become easily disturbed if subjected to conventional rubber tire or narrow track-type equipment. Soils that become disturbed would need to be excavated and replaced; however, this remedial excavation may expose progressively wetter soils with depth, thus compounding the problem condition. Thus, a normal approach to subgrade preparation may not be possible. Appropriate wide-track equipment selection should aid in minimizing potential disturbance.

After stripping to the proposed subgrade level, as required, the building and pavement areas should be proof-rolled with a loaded tandem-axle dump truck or similar heavy rubber tired vehicle (typically with an axial load greater than nine (9) tons). Soils that are observed to rut or deflect excessively (typically greater than one (1) inch) under the moving load should be undercut and replaced with properly compacted low plasticity fill material. The proof-rolling and undercutting activities should be witnessed by a representative of the geotechnical engineer and should be performed during a period of dry weather. If the earthwork activities take place during wet seasons, lime stabilization of the subgrade could be required prior to engineered fill placement. Care should be taken during construction activities not to allow excessive drying or wetting of exposed soils. The subgrade soils should be scarified and compacted to at least 98% of the materials’ standard Proctor maximum dry density, in general accordance with ASTM procedures, to a depth of at least twelve (12) inches below the surface. New fill for building structures, asphalt, and concrete should not be placed on frozen ground.

After subgrade preparation and observation have been completed, fill placement required to establish grade may begin. Low-plasticity structural fill materials placed beneath structural features or slabs should be free of organic or other deleterious materials and have a maximum particle size of less than three (3) inches. Low-plasticity soils are defined as having a liquid limit less than forty-five (45) and plasticity index between ten (10) and twenty (20) percent. The in-situ lean clay and clayey sand materials can be reused as engineered fill if they are free of any organic material and meet the requirements outlined in this report. A representative of PSI should be on-site to observe, test, and document the placement of the fill. If the fill is too dry, water should be uniformly applied and thoroughly mixed into the soil by diskng or scarifying. Close moisture content control will be required to achieve the recommended degree of compaction. If wet or cool season earthwork is necessary, PSI recommends the use of imported fill materials meeting the requirements of Ohio Department of Transportation (ODOT) No. 304 aggregate.
Fill should be placed in maximum loose lifts of eight (8) inches and compacted to at least 98% of the materials’ standard Proctor maximum dry density, and within a range of the optimum moisture content as designated in the table below, as determined in general accordance with ASTM procedures. Each lift of compacted-engineered fill should be tested and documented by a representative of the geotechnical engineer prior to placement of subsequent lifts. The edges of compacted fill should extend a minimum of five (5) feet beyond the building footprint, or a distance equal to the depth of fill beneath the footings, whichever is greater. The measurement should be taken from the outside edge of the footing to the toe of the excavation prior to sloping.

In utility trenches, shallow foundation excavations, and other areas where large compaction equipment cannot be used, granular engineered fill should be placed as backfill. PSI recommends the use of material meeting Ohio Department of Transportation (ODOT) No. 304, for use as granular engineered fill. Engineered fill should be placed in accordance with the recommendations stated in this section of the report.

The fill placed should be tested and documented by a geotechnical technician and directed by a geotechnical engineer to evaluate the placement of fill material. It should be noted that the geotechnical engineer of record can only certify the testing that is performed and the work observed by that engineer or staff in direct report to that engineer. The fill should be evaluated in accordance with the following Table:

<table>
<thead>
<tr>
<th>MATERIAL TESTED</th>
<th>PROCTOR TYPE</th>
<th>MIN % DRY DENSITY</th>
<th>PLACEMENT MOISTURE CONTENT RANGE</th>
<th>FREQUENCY OF TESTING *1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Lean Clay Fill (Cohesive)</td>
<td>Standard</td>
<td>98%</td>
<td>-2 to +2 %</td>
<td>1 per 5,000 ft² of fill placed / lift</td>
</tr>
<tr>
<td>Structural Fill (Granular)</td>
<td>Standard</td>
<td>98%</td>
<td>-2 to +2 %</td>
<td>1 per 5,000 ft² of fill placed / lift</td>
</tr>
<tr>
<td>Random Fill (non load bearing)</td>
<td>Standard</td>
<td>90%</td>
<td>-3 to +3 %</td>
<td>1 per 6,000 ft² of fill placed / lift</td>
</tr>
<tr>
<td>Utility Trench Backfill</td>
<td>Standard</td>
<td>98%</td>
<td>-2 to +2 %</td>
<td>1 per 150 lineal foot / lift</td>
</tr>
</tbody>
</table>

*1 Minimum 2 per lift.

Tested fill materials that do not achieve either the required dry density or moisture content range shall be recorded, the location noted, and reported to the Contractor and Owner. A re-test of that area should be performed after the Contractor performs remedial measures.

**Building Foundation Recommendations**

The planned construction can be supported on conventional spread-type footing foundations bearing on either competent naturally deposited soils, properly compacted, tested, and documented engineered fill, or lean concrete monoliths bearing on competent natural soils. If it is desired for the planned foundations to bear on properly compacted and documented fill, the geotechnical engineer should be allowed to review the material to verify its consistency with the recommended bearing
pressures. **Spread footings for building columns and continuous footings for bearing walls can be designed for a net allowable soil bearing pressure of 3,000 and 2,500 pounds per square foot (psf), respectively.** These values are based on assumed dead load plus design live load and contain a safety factor of 3. PSI recommends a minimum dimension of thirty (30) inches for square footings and twelve (18) inches for continuous footings to minimize the possibility of a local bearing capacity failure.

Exterior footings and footings in unheated areas should be located at a depth of thirty-two (32) inches or deeper below the final exterior grade to provide adequate frost protection. If the building is to be constructed during the winter months or if footings will likely be subjected to freezing temperatures after foundation construction, then the footings should be protected from freezing. PSI recommends that interior footings be a minimum depth of eighteen (18) inches below the finished floor elevation.

It should be noted that a clayey sand was encountered at a depth of 3 feet in soil test boring B-6 and at deeper depths in the remaining borings. It is possible for this material to have “perched” water and to require dewatering for excavations that extend within 2 feet of the material. The groundwater level must be maintained at least 2 feet below the deepest excavation until construction is completed. This material also has the potential to “fluff” up when dry and may require moisture conditioning and recompaction after excavation if it becomes disturbed. A PSI engineering technician should observe and test the foundation excavations during the construction process.

The foundation excavations should be observed, documented and tested by a representative of PSI prior to steel or concrete placement to assess that the foundation materials are consistent with the materials discussed in this report, and therefore can support the design loads. Soft or loose soil zones encountered at the bottom of the footing excavations should be removed to the level of suitable natural soils, and replaced with adequately compacted structural fill. Fill placed below the foundations where unsuitable materials are removed should extend one half (½) foot outside the foundation limits for every one (1) foot in thickness between the intended bearing surface and the underlying, suitable natural soils. Alternately, the foundations may be extended through unsuitable soils to bear on the underlying suitable material. Cavities formed because of excavation of soft or loose soil zones should be backfilled with lean concrete or dense graded compacted crushed stone.

After opening, footing excavations should be observed and concrete placed as quickly as possible to avoid exposure of the footing bottoms to wetting and drying. Surface run-off water should be drained away from the excavations and not be allowed to pond. If possible, the foundation concrete should be placed during the same day the excavation is made. If it is required that footing excavations be left open for more than one day, they should be protected to reduce evaporation or entry of moisture.

Based on the known subsurface conditions and site geology, laboratory testing and past experience, PSI anticipates that properly designed and constructed footings supported on the recommended materials should experience total and differential settlement between adjacent columns of less than one (1) inch and ¾ inch, respectively.

Be advised that as a part of the foundation selection process, there is a cost/benefit evaluation. Although PSI is recommending a specific foundation type, we have not accomplished the cost/benefit evaluation.
Below-Grade Walls

Below-grade walls should be designed to resist lateral earth pressures. Lateral earth pressure is developed from the soils present within a wedge formed by the vertical below-grade wall and an imaginary line extending up and away from the bottom of the wall at an approximate 45° angle. The lateral earth pressures are determined by multiplying the vertical applied pressure by the appropriate lateral earth pressure coefficient K. Since the walls are rigidly attached to the structure and not free to rotate or deflect at the top, PSI recommends designing the walls for the “at-rest” lateral earth pressure condition using \( K_o \). Walls that are permitted to rotate and deflect at the top can be designed for the active lateral earth pressure condition using \( K_a \). Passive pressure can be determined using \( K_p \). Recommended parameters for design of below-grade walls are as follows:

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Drained Friction Angle (( \phi' ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Sandy Lean Clay (in-situ)</td>
<td>24°</td>
</tr>
<tr>
<td>2) Sandy Lean Clay (conditioned and compacted)</td>
<td>26°</td>
</tr>
<tr>
<td>3) Granular Soils (clean crushed limestone)</td>
<td>35°</td>
</tr>
</tbody>
</table>

Total Soil Density (pcf) 125

Cohesion for Clay Soils (psf) (undrained, \( \phi = 0 \)) 500

Groundwater Elevation At Bottom of Wall

<table>
<thead>
<tr>
<th>Parameters specific to soil type</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friction Factor for Base</td>
<td>0.32</td>
<td>0.35</td>
<td>0.39</td>
</tr>
<tr>
<td>Coefficient of Active Pressure (( K_a )) **</td>
<td>0.42</td>
<td>0.39</td>
<td>0.27</td>
</tr>
<tr>
<td>Coefficient of Passive Pressure (( K_p )) **</td>
<td>2.37</td>
<td>2.56</td>
<td>3.68</td>
</tr>
<tr>
<td>Coefficient of At-Rest Pressure (( K_o )) **</td>
<td>0.59</td>
<td>0.56</td>
<td>0.43</td>
</tr>
</tbody>
</table>

*These values may be used for design only if the crushed limestone backfill extends back from the wall certain distances. These are a horizontal distance approximately equal to or greater than the total height of the wall at the surface, and at least one-foot beyond the heel of the wall footing.

The values presented in the table are ultimate values and were calculated based on positive foundation drainage being provided to prevent the buildup of hydrostatic pressure. If surface loads are placed near the walls, such as traffic loads, they should be designed to resist an additional uniform lateral load of one-half of the vertical surface loads. An “equivalent fluid” pressure can be obtained from the above chart by multiplying the appropriate K-factor times the total unit weight of the soil. This applies to unsaturated conditions only. If a saturated “equivalent fluid” pressure is needed, the effective unit weight (total unit weight minus unit weight of water) should be multiplied times the appropriate K-factor and the unit weight of water added to that resultant. However, PSI does not recommend that below-grade walls be designed with a hydrostatic load and that drainage should be provided to relieve the pressure. The values provided are ultimate and an approximate safety factor should be used in the design.

The values provided above do not include forces due to swelling of high plasticity soils. It is recommended that materials with a Plasticity Index greater than 20 not be used as backfill or remain in place within 5 feet of a below grade wall. In addition, a drainage system must be installed to reduce the potential for water to pond behind the wall and allow the high plasticity soils to swell which will exert force upon the wall which result in distress to and/or failure of the wall.
The design of below grade walls should include the effects of geometry and loading conditions. The following charts have been included from NAVFAC 7.02 concerning slopes in the grade at the top of below grade wall. Depending on the geometry of the site, the lateral loading on the below grade wall should be modified according to these charts.

Soil Type 1 – Clean Sand and Gravel, GW, GP, SW, SP
Soil Type 2 – Dirty Sand and Gravel of Restricted Permeability, GM, GM-GP, SM-SP, SM

**Below-Grade Wall Back-Drain**

PSI recommends that below grade walls be adequately water-proofed and be provided with a wall back-drain system. One possible drainage system is shown in the sketch below and would include:

I. A four (4) or six (6) inch diameter perforated drain tile at the bottom of the backfill to collect seepage water with the tile connected to a suitable means of disposal.
II. Clean washed, ½ inch or one (1) inch gravel classified as "GP" surrounding the drain tile and placed within twelve (12) inches of the wall.
III. Non-woven four (4) ounce per square yard geotextile between the drainage material and the on-site soils or backfill to prevent infiltration of fine grained soils into the drain tile, granular drainage blanket, or granular backfill.
As an alternative, a geocomposite drain material can be placed between the below-grade wall and the backfill soils. Underdrains, sub-drains and underslab drains presented in this report will not prevent moisture vapor that can cause mold growth.

The placement of a limited amount of granular material behind a below-grade wall does not appreciably change the coefficient of lateral earth pressure acting on that wall. The lateral earth pressure acting on a below-grade structure is a function of the weight of the soil that exists above the theoretical plane projecting up from the base of the wall. The soil above this plane is held in place by two forces, the strength of the soil itself and the lateral resistance of the below-grade wall. Therefore, a thin layer of granular material behind the wall is of little consequence on the forces acting on the wall.

Below-Grade Wall Backfill and Compaction

Backfill of the below-grade walls may consist of low plasticity soils or granular material. PSI suggests using granular material to provide improved drainage and to reduce lateral pressures on the walls resulting from water pressure. The backfill materials should be placed in lifts that do not exceed 8-inches loose. The lift thickness may need to be reduced to thinner lifts immediately behind the walls to achieve the desired amount of compaction without overstressing the wall with the compaction process.

Backfill should be placed in thin lifts and mechanically compacted to at least 98% of the materials’ maximum dry density and within 2% of the optimum water content as determined by the Standard Proctor test. PSI advises performing field density tests on the backfill to monitor compliance with the recommendations provided. Care should be exercised during the backfilling operation to prevent overstressing and damaging the walls.
Earthquake and Seismic Design Consideration

The 2009 International Building Code requires a site class for the calculation of earthquake design forces. This class is a function of soil type (i.e., depth of soil and strata types). Based on the depth to rock and the estimated shear strength of the soil at the boring locations, Site Class “C” is recommended. The United States Geological Survey National Earthquake Hazard Reduction Program (USGS-NEHRP) probabilistic ground motion values “C” are as follows:

<table>
<thead>
<tr>
<th>Period (seconds)</th>
<th>Site Coefficients</th>
<th>Max. Spectral Acceleration Parameters</th>
<th>Design Spectral Acceleration Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.185 (Sₚ)</td>
<td>Fₘ = 1.2</td>
<td>Sₘₘ = 0.222</td>
<td>Sₘₘₘₘ = 0.148</td>
</tr>
<tr>
<td>0.069 (S₁)</td>
<td>Fᵥ = 1.7</td>
<td>Sₘ₁ = 0.117</td>
<td>Sₘₘ₁ₘ = 0.078</td>
</tr>
</tbody>
</table>

The Site Coefficients, Fₘ and Fᵥ were interpolated from IBC 2009 Tables 1613.5.3 (1) and 1613.5.3 (2) as a function of the site classifications and the mapped spectral response acceleration at the short (Sₚ) and 1 second (S₁) periods.

According to Section 1613.5.6 of IBC 2009, sites supporting structures in design category “D” and below must be evaluated for slope instabilities, liquefaction and surface rupture due to faulting or lateral spreading. A detailed study of these effects was beyond PSI’s scope of services. However, the following table presents a qualitative assessment of these issues considering the site class, the subsurface soil properties, the groundwater elevation, and probabilistic ground motions:

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Relative Risk</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquefaction</td>
<td>Low</td>
<td>The soil within the upper 50 feet of the subsurface profile is a relatively dense and/or cohesive soil</td>
</tr>
<tr>
<td>Slope Stability</td>
<td>Low</td>
<td>The site is relatively flat and does not/will not incorporate significant cut or fill slopes</td>
</tr>
<tr>
<td>Surface Rupture</td>
<td>Low</td>
<td>The site is not underlain by a mapped Holocene-aged fault</td>
</tr>
</tbody>
</table>

Floor Slab Recommendations

It should be noted that undocumented fill material was encountered in the area of soil test boring B-4 to a depth of approximately 3 feet and may be encountered in other areas of the site and to greater depths. The most positive method of supporting the floor slab in areas of undocumented fill is to remove the undocumented fill and replace it with compacted and tested structural fill. We did not observe trash or organics in the fill, so as an alternate, if the owner is willing to accept some risk of potential future vertical movement of the floor slab, the fill could remain in place and be proof rolled to evidence any soft spots. Once the site area has been prepared in accordance with the “Site Preparation” section of this report, the floor slab can be grade supported on a minimum 2 feet non-expansive engineered fill or native undisturbed soil. Proof-rolling, as discussed earlier in this report, should be accomplished after topsoil removal to identify soft or unstable soils that should be removed from the floor slab area prior to fill placement and/or floor slab construction. These soils should be replaced with properly compacted structural fill as described earlier in this report. The owner should
be involved in the decision process regarding whether to leave undocumented fill in place due to the risk of future vertical movement. Leaving fill in place also increases the risk of odors or gas permeating into the structure over time and should be considered in the design and used in the evaluation of leaving undocumented fill in place and constructing upon it.

PSI recommends that a minimum six (6) inch thick trimmable, compactable granular material be placed beneath the floor slab to enhance drainage. The soil surface shall be graded to drain away from the building without low spots that can trap water prior to placing the granular drainage layer. Polyethylene sheeting should be placed to act as a vapor retarder where the floor will be in contact with moisture sensitive equipment or products such as tile, wood, carpet, etc., as directed by the design engineer. The decision to locate the vapor retarder in direct contact with the slab or beneath the layer of granular fill should be made by the design engineer after considering the moisture sensitivity of subsequent floor finishes, anticipated project conditions, and the potential effects of slab curling and cracking. The floor slabs should have an adequate number of joints to reduce cracking resulting from differential movement and shrinkage.

For subgrade prepared as recommended and properly compacted fill, a modulus of subgrade reaction, $k$ value, of 125 pounds per cubic inch (pci) may be used in the grade slab design based on correlation to values typically resulting from a 1 ft. x 1 ft. plate load test. However, depending on how the slab load is applied, the value should be geometrically modified. The value should be adjusted for larger areas using the following expression for cohesive and cohesionless soil:

$$Modulus\ of\ Subgrade\ Reaction, \ k_s = \left( \frac{k}{B} \right) \ for \ cohesive \ soil \ and$$

$$k_s = k \left( \frac{B + 1}{2B} \right)^2 \ for \ cohesionless \ soil$$

where: $k_s$ = coefficient of vertical subgrade reaction for loaded area,
$k$ = coefficient of vertical subgrade reaction for 1 square foot area, and
$B$ = effective width of area loaded, in feet

The precautions listed below should be followed for construction of slab-on-grade pads. These details will not reduce the amount of movement, but are intended to reduce potential damage should some settlement of the supporting subgrade take place. Some increase in moisture content is inevitable because of development and associated landscaping. However, extreme moisture content increases can be largely controlled by proper and responsible site drainage, building maintenance and irrigation practices.

- Cracking of slab-on-grade concrete is normal and should be expected. Cracking can occur not only because of heaving or compression of the supporting soil and/or bedrock material, but also because of concrete curing stresses. The occurrence of concrete shrinkage crack, and problems associated with concrete curing may be reduced and/or controlled by limiting the slump of the concrete, proper concrete placement, finishing, and curing, and by the placement of crack control joints at frequent intervals, particularly where re-entrant slab corners occur. The American Concrete Institute (ACI) recommends a maximum panel size (in feet) equal to approximately three times the thickness of the slab (in inches) in both directions. For example, joints are recommended at a maximum spacing of twelve (12) feet based on having a four-inch slab. PSI also recommends that the slab be independent of the foundation walls. Using fiber reinforcement in the concrete can also control shrinkage cracking.
• Areas supporting slabs should be properly moisture conditioned and compacted. Backfill in all interior and exterior water and sewer line trenches should be carefully compacted to reduce the shear stress in the concrete extending over these areas.

Exterior slabs should be isolated from the building. These slabs should be reinforced to function as independent units. Movement of these slabs should not be transmitted to the building.

Utilities Trenching

Excavation for utility trenches shall be performed in accordance with OSHA regulations as stated in 29 CFR Part 1926. It should be noted that utility trench excavations have the potential to degrade the properties of the adjacent fill materials. Utility trench walls that can move laterally can lead to reduced bearing capacity and increased settlement of adjacent structural elements and overlying slabs.

Backfill for utility trenches is as important as the original subgrade preparation or structural fill placed to support either a foundation or slab. Therefore, it is imperative that the backfill for utility trenches be placed to meet the project specifications for the structural fill of this project. PSI recommends that flowable fill or lean mix concrete be utilized for utility trench backfill. If on-site soils are placed as trench backfill, the backfill for the utility trenches should be placed in four (4) to six (6) inch loose lifts and compacted to a minimum of 98% of the maximum dry density achieved by the standard Proctor test. The backfill soil should be moisture conditioned to be within 2% of the optimum moisture content as determined by the standard Proctor test. Up to four (4) inches of bedding material placed directly under the pipes or conduits placed in the utility trench can be compacted to the 90% compaction criteria with respect to the standard Proctor. Compaction testing should be performed for every 200 cubic yards of backfill place or each lift within 200 linear feet of trench, whichever is less.

Backfill of utility trenches should not be performed with water standing in the trench. If granular material is used for the backfill of the utility trench, the granular material should have a gradation that will filter protect the backfill material from the adjacent soils. If this gradation is not available, a geosynthetic non-woven filter fabric should be used to reduce the potential for the migration of fines into the backfill material. Granular backfill material shall be compacted to meet the above compaction criteria. The clean granular backfill material should be compacted to achieve a relative density greater than 75% or as specified by the geotechnical engineer for the specific material used.

Siltation Control

The Clean Water Act, implemented in 1990 includes a federal permit program called the National Pollutant Discharge Elimination System (NPDES). This program requires that projects sites more than one (1) acre or are part of a development which exceeds one (1) acre be covered under a permit. This typically includes the development of a storm water pollution prevention plan (SWPPP) as well as period inspections (typically once a week plus after significant rainfall). PSI is available to assist with these services.

Pavement Recommendations

No traffic information was available for the proposed development. However, the pavement design is based on the anticipated design 18-kip EAL’s of 30,000 and 100,000 for the planned Flexible Standard Duty Pavement areas and Heavy Duty Pavement areas, respectively. Also, the anticipated design life is 20 years. Based on the anticipated pavement design information and CBR value of 5 (determined from empirical correlations), typical flexible pavement section for the proposed development is as follows:
Flexible Pavement

Table 7: Flexible Pavement Sections (20-Year Design Life)

<table>
<thead>
<tr>
<th>Layer</th>
<th>Light-Duty*</th>
<th>Heavy-Duty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Course (ODOT #448 Type 1)</td>
<td>1.5 inches</td>
<td>1.5 inches</td>
</tr>
<tr>
<td>Intermediate Course (ODOT #448 Type 2)</td>
<td>1.5 inches</td>
<td>2.5 inches</td>
</tr>
<tr>
<td>Aggregate Base Course (ODOT #304)</td>
<td>8.0 inches</td>
<td>10.0 inches</td>
</tr>
<tr>
<td>Subgrade Geogrid Reinforcement</td>
<td>As Required</td>
<td>As Required</td>
</tr>
</tbody>
</table>

*Parking stalls only.

For parking stalls that allow free movement through them (i.e. no parking block or curbs), we recommend installing the recommended heavy-duty asphalt section. Allowances for proper drainage and proper material selection of base materials are most important for performance of asphaltic pavements. Ruts and birdbaths in asphalt pavement allow for quick deterioration of the pavement primarily due to saturation of the underlying base and subgrade.

The pavement sections should have equivalent thickness throughout the pavement areas. Additionally, prime coat will be required between the aggregate course and intermediate course. However, tack coat is not required if the surface coarse and intermediate coarse are installed simultaneously.

PSI recommends that the bituminous concrete mix meet the general guidelines as outlined in ODOT Item 448 for the base and surface courses. The granular base course should be built at least 2 feet wider than the pavement on each side to support the tracks of the slipform paver. This extra width is structurally beneficial for wheel loads applied at pavement edge. The asphalt surface and binder course should be compacted to a minimum of 92% of the Maximum Theoretical Density as determined by ASTM D2041.

Rigid Pavement

Because the pavement at this site will be subjected to freeze-thaw cycles, PSI recommends that an air entrainment admixture be added to the concrete mix to achieve an air content in the range of 5% to 7% to provide freeze-thaw durability in the concrete. Concrete with a minimum 28 day specified compressive strength of 4,000 psi should be used. The mixture should have a maximum slump of four (4) inches. If a water reducing admixture is used in the mix design, then the slump can be increased. It is recommended that a concrete mix design including any admixtures be submitted to the owner in advance of use at the project site.

Pavement for any areas subject to consistent heavy loads should be constructed of Portland cement concrete with load transfer devices installed where construction joints are required. A thickened edge is recommended on the outside of slabs subjected to wheel loads. This thickened edge usually takes the form of an integral curb. Fill material should be compacted behind the curb or the edge of the outside slabs should be thickened. The following are recommended to enhance the quality of the pavement.

- Moisten subgrade just prior to placement of concrete
- Cure fresh concrete with a liquid membrane-forming curing compound
- Keep automobile traffic off the slab for three (3) days and truck traffic off the slab for seven (7) days, unless tests are made to determine that the concrete has gained adequate strength (i.e., usually 70% of design strength)
Table 8: Rigid Pavement Sections

<table>
<thead>
<tr>
<th>Rigid (Concrete) Pavement</th>
<th>Light-Duty*</th>
<th>Heavy-Duty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforced Concrete</td>
<td>6 inches</td>
<td>8 inches</td>
</tr>
<tr>
<td>Aggregate Base Course (ODOT #304)</td>
<td>6 inches</td>
<td>6 inches</td>
</tr>
<tr>
<td>Subgrade Geogrid Reinforcement</td>
<td>As Required</td>
<td>As Required</td>
</tr>
</tbody>
</table>

*Parking stalls only.

The recommended sections represent minimum design thicknesses. Furthermore, the required pavement thicknesses should be evaluated based on actual traffic loads. Periodic maintenance of the pavement structures should be expected.

**Pavement Subgrade Preparation**

Prior to paving, the prepared subgrade should be proof-rolled using a loaded tandem axle dump truck or similar type of pneumatic tired equipment with a minimum gross weight of nine (9) tons per single axle. Undocumented fill soils, if encountered, should be removed as described in the Site Preparation section of this report. Localized soft areas identified should be repaired prior to paving. Engineered fill should be compacted to a minimum 98 percent of maximum dry density and within +/- 2 percent of optimum moisture in accordance with ASTM D-698 (Standard). It may require rework when the subgrade is either desiccated or wet.

Construction traffic should be minimized to prevent unnecessary disturbance of the pavement subgrade. Disturbed areas, as verified by PSI, should be removed and replaced with properly compacted material.

The edges of compacted fill should extend a minimum two (2) feet beyond the edges of the pavement, or a distance equal to the depth of fill beneath the pavement, whichever is greater. The measurement should be taken from the outside edge of the pavement to the toe of the excavation prior to sloping.

**Pavement Drainage & Maintenance**

PSI recommends pavements be sloped to provide rapid surface drainage. Water allowed to pond on or adjacent to the pavement could saturate the subgrade and cause premature deterioration of the pavements, and removal and replacement may be required. **It must be emphasized that if water can pond beneath the pavement, then freeze-thaw cycles will cause subsequent heaving of the pavement section (and ultimately failure).** Consideration should be given to the use of interceptor drains to collect and remove water collecting in the granular base. The interceptor drains could be incorporated with the storm drains of other utilities located in the pavement areas.

Periodic maintenance of the pavement should be anticipated. This should include sealing of cracks and joints and by maintaining proper surface drainage to avoid ponding of water on or near the pavement areas. Underdrains, sub-drains and under-slab drains presented in this report will not prevent moisture vapor that can cause mold growth.
CONSTRUCTION CONSIDERATIONS

PSI should be retained to provide observation and testing of construction activities involved in the foundation, earthwork, and related activities of this project. PSI cannot accept responsibility for conditions that deviate from those described in this report, nor for the performance of the foundation system if not engaged to also provide construction observation and testing for this project.

Moisture Sensitive Soils/Weather Related Concerns

The upper fine-grained soils encountered at this site will be sensitive to disturbances caused by construction traffic and to changes in moisture content. During wet weather periods, increases in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. In addition, soils that become wet may be slow to dry and thus significantly retard the progress of grading and compaction activities. It will, therefore, be advantageous to perform earthwork and foundation construction activities during dry weather.

Drainage and Groundwater Considerations

PSI recommends that the Contractor determine the actual groundwater levels at the site at the time of the construction activities to assess the impact groundwater may have on construction. Water should not be allowed to collect in the foundation excavation, on floor slab areas, or on prepared subgrades of the construction area either during or after construction. Undercut or excavated areas should be sloped toward one corner to facilitate removal of collected rainwater, groundwater, or surface runoff. Positive site drainage should be provided to reduce infiltration of surface water around the perimeter of the building and beneath the floor slabs. The grades should be sloped away from the building and surface drainage should be collected and discharged such that water is not permitted to infiltrate the backfill and floor slab areas of the building.

Excavations

In Federal Register, Volume 54, Number 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, part 1926, Subpart P". This document was issued to better enhance the safety of workers entering trenches or excavations. It is mandated by this federal regulation that excavations, whether they be utility trenches, basement excavation or footing excavations, be constructed in accordance with the new OSHA guidelines. It is PSI's understanding that these regulations are being strictly enforced and if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case, should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations.

PSI is providing this information solely as a service to our client. PSI does not assume responsibility for construction site safety or the contractor's or other parties' compliance with local, state, and federal safety or other regulations. A trench safety plan was beyond the scope of our services for this project.
GEOTECHNICAL RISK

The concept of risk is an important aspect of the geotechnical evaluation. The primary reason for this is that the analytical methods used to develop geotechnical recommendations do not comprise an exact science. The analytical tools which geotechnical engineers use are generally empirical and must be used in conjunction with engineering judgment and experience. Therefore, the solutions and recommendations presented in the geotechnical evaluation should not be considered risk-free and, more importantly, are not a guarantee that the interaction between the soils and the proposed structure will perform as planned. The engineering recommendations presented in the preceding section constitutes PSI’s professional estimate of those measures that are necessary for the proposed structure to perform according to the proposed design based on the information generated and referenced during this evaluation, and PSI’s experience in working with these conditions.

REPORT LIMITATIONS

The recommendations submitted are based on the available subsurface information obtained by PSI and design details furnished by Dayton Design Collaborative and Levin Porter Associates, Inc. If there are revisions to the plans for this project or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI should be notified immediately to determine if changes in the foundation recommendations are required. If PSI is not retained to perform these functions, PSI will not be responsible for the impact of those conditions on the project.

The geotechnical engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

After the plans and specifications are more complete, the geotechnical engineer should be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated into the design documents. At that time, it may be necessary to submit supplementary recommendations. This report has been prepared for the exclusive use of Levin Porter Associates, Inc. and Dayton Design Collaborative for the specific application to the proposed Dayton Metro Library Segment 3 – Southeast Branch Library project located on the southwest corner of the intersection of Wayne Avenue and Watervliet Avenue in Dayton, Montgomery County, Ohio.
Appendix
Boring Location Plan
DML Segment 3 - Southeast Branch
Wayne Avenue & Watervliet Avenue
Dayton, Ohio 45420

Professional Service Industries

Drawing Provided By: Levin-Porter Associates, Inc.
Date: 1/25/2017

- Indicates Approximate Test Boring Location
### MATERIAL DESCRIPTION

<table>
<thead>
<tr>
<th>Depth, (feet)</th>
<th>USCS Classification</th>
<th>SPT Blows per 6-inch (SS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>TOPSOIL (4&quot;)</td>
<td></td>
</tr>
<tr>
<td>1-18</td>
<td>Very Stiff to Hard, Moist to Damp, Brown, SANDY LEAN CLAY</td>
<td></td>
</tr>
<tr>
<td>2-18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-12</td>
<td>CLS</td>
<td>6-9-15, N_p=34</td>
</tr>
<tr>
<td>4-18</td>
<td></td>
<td>5-9-12, N_p=30</td>
</tr>
<tr>
<td>5-16</td>
<td>SW-SC</td>
<td>8-9-13, N_p=31</td>
</tr>
<tr>
<td>6-16</td>
<td></td>
<td>11-14-15, N_p=41</td>
</tr>
<tr>
<td>7-9</td>
<td></td>
<td>17-23-46, N_p=98</td>
</tr>
<tr>
<td>14  feet</td>
<td></td>
<td>23-50/4</td>
</tr>
<tr>
<td>24.3'</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Location Information

- **LATITUDE:** 39.738756°
- **LONGITUDE:** 84.152722°
- **PROJECT:** DML Southeast Branch
- **LOCATION:** Wayne Ave and Watervliet
- **ELEVATION:** N/A
- **DATE COMPLETED:** 1/16/17
- **DATE STARTED:** 1/16/17
- **DRILL COMPANY:** Central Star
- **DRILLER:** TS
- **LOGGED BY:** DR
- **REVIEWED BY:** RAS
- **REMARKS:** N<sub>60</sub> denotes the normalization to 60% efficiency as described in ASTM D4633.
### BORING B-2

#### MATERIAL DESCRIPTION

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<th>Elevation (feet)</th>
<th>Depth, (feet)</th>
<th>Graphic Log</th>
<th>Sample No.</th>
<th>Sample Type</th>
<th>Recovery (inches)</th>
<th>MATERIAL DESCRIPTION</th>
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</thead>
<tbody>
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<td>0</td>
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<td>CLS</td>
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<td>4-5-5</td>
<td>4-5-5 Moist = 14</td>
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<td>16</td>
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<td>SW-SC</td>
<td>2-3-4 Moist = 10</td>
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<tr>
<td>5</td>
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<td></td>
<td></td>
<td>15-23-21 Moist = 62</td>
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<tr>
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<td>End of boring, 25'</td>
</tr>
</tbody>
</table>

#### STANDARDS PENETRATION TEST DATA

- **N in blows/ft**: Moist = 0, PL = 20, LL = 40, Qu = 2.0, Qp = 4.0
- **SPT Blows per 6-inch (SS)**
  - 4-4-5 Moist = 13
  - 2-1-3 Moist = 6
  - 4-5-5 Moist = 14
  - 2-3-4 Moist = 10
  - 11-12-14 Moist = 14
  - 16-38-37 Moist = 106
  - 15-23-21 Moist = 62

#### ADDITIONAL REMARKS

- N denotes the normalization to 60% efficiency as described in ASTM D4633.

### LOCATION

- **LATITUDE**: 39.7386°
- **LONGITUDE**: 84.15285°
- **LOCATION**: Wayne Ave and Watervliet, Dayton, Ohio 45420

---

**DATE STARTED**: 1/16/17  
**DATE COMPLETED**: 1/16/17  
**COMPLETION DEPTH**: 25.0 ft  
**BENCHMARK**: N/A  
**ELEVATION**: N/A  
**LATITUDE**: 39.7386°  
**LONGITUDE**: 84.15285°  
**STATION**: N/A  
**OFFSET**: N/A  
**REMARKS**: N denotes the normalization to 60% efficiency as described in ASTM D4633.

**DRILL COMPANY**: Central Star  
**DRILLER**: TS  
**LOGGED BY**: DR  
**REVIEWED BY**: RAS  
**PROJECT NO.**: 01051073  
**PROJECT**: DML Southeast Branch  
**LOCATION**: Wayne Ave and Watervliet, Dayton, Ohio 45420  
**DATE STARTED**: 1/16/17  
**BENCHMARK**: N/A  
**ELEVATION**: N/A  
**LATITUDE**: 39.7386°  
**LONGITUDE**: 84.15285°  
**STATION**: N/A  
**OFFSET**: N/A  
**REMARKS**: N denotes the normalization to 60% efficiency as described in ASTM D4633.

---

*The stratification lines represent approximate boundaries. The transition may be gradual.*
The stratification lines represent approximate boundaries. The transition may be gradual.
TOPSOIL (4")
Stiff, Damp, Brown, SANDY LEAN CLAY, FILL

FILL
4-4-5
N<sub>60</sub>=13

Stiff, Moist, Brown, SANDY LEAN CLAY

CLS
4-6-8
N<sub>60</sub>=20

Dense to Extremely Dense, Damp, Brown and Gray, WELL-GRADED SAND WITH CLAY AND GRAVEL

3-4-4
N<sub>60</sub>=11

9-12-14
N<sub>60</sub>=37

9-18-20
N<sub>60</sub>=54

SW-SC

12-22-29
N<sub>60</sub>=72

30-50/1

End of boring, 24.1'
**BORING B-5**

**DATE STARTED:** 1/16/17  
**DATE COMPLETED:** 1/16/17  
**COMPLETION DEPTH:** 25.0 ft  
**BENCHMARK:** N/A  
**ELEVATION:** N/A  
**LATITUDE:** 39.738675°  
**LONGITUDE:** 84.152283°  
**STATION:** N/A  
**OFFSET:** N/A  
**REMARKS:** N60 denotes the normalization to 60% efficiency as described in ASTM D4633.

### MATERIAL DESCRIPTION

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<th>Elevation (feet)</th>
<th>Depth (feet)</th>
<th>Sample No.</th>
<th>Recovery (inches)</th>
<th>TOPSOIL Classification</th>
<th>SPT Blows per 6-inch (SS)</th>
<th>USD Classification</th>
<th>SPT Blows per 6-inch (SS)</th>
<th>USCS Classification</th>
<th>Moisture, %</th>
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</table>

**STANDARD PENETRATION TEST DATA**

- **N in blows/ft**: 22
- **Moisture %**: 5

**STRENGTH, tsf**

- **Qu**: 4.0
- **Qp**: 2.0

**Graphic Log**

- **While Drilling**: N/A feet
- **Upon Completion**: N/A feet

**Location**: Wayne Ave and Watervliet

**DRILL COMPANY**: Central Star  
**DRILLER**: TS  
**LOGGED BY**: DR  
**REVIEWED BY**: RAS

**PROJECT NO.**: 01051073  
**PROJECT**: DML Southeast Branch  
**LOCATION**: Dayton, Ohio  
**DATE STARTED**: 1/16/17  
**DATE COMPLETED**: 1/16/17  
**COMPLETION DEPTH**: 25.0 ft  
**ELEVATION**: N/A  
**LATITUDE**: 39.738675°  
**LONGITUDE**: 84.152283°  
**STATION**: N/A  
**OFFSET**: N/A  

**REMARKS**: The stratification lines represent approximate boundaries. The transition may be gradual.
**MATERIAL DESCRIPTION**

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Depth (feet)</th>
<th>Recovery (inches)</th>
<th>Graphic Log</th>
<th>Sample Type</th>
<th>USCS Classification</th>
<th>SPT Blow per 6-inch</th>
<th>Standard Penetration Test Data</th>
<th>Moisture, %</th>
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<td>WELL- GRADED SAND</td>
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</tbody>
</table>

**Additional Remarks:**
- N denotes the normalization to 60% efficiency as described in ASTM D4633.
- **Topsoil (4"):** Hard, Damp, Brown, Sandy Lean Clay
- Medium Dense, Damp, Brown, Clayey Sand
- Dense, Damp, Brown, Well-Graded Sand with Clay and Gravel
- Dense to Extremely Dense, Damp, Brown and Gray, Well-Graded Sand with Clay and Gravel

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**BOARING B-6**

**DATE STARTED:** 1/16/17  
**DATE COMPLETED:** 1/16/17  
**COMPLETION DEPTH:** 25.0 ft  
**BENCHMARK:** N/A  
**ELEVATION:** N/A  
**LATITUDE:** 39.738472°  
**LONGITUDE:** 84.152031°  
**STATION:** N/A  
**OFFSET:** N/A  

**DRILL COMPANY:** Central Star  
**DRILLER:** TS  
**LOGGED BY:** DR  
**DRILL RIG:** Diedrich D50  
**DRILLING METHOD:** Hollow Stem Auger  
**SAMPLING METHOD:** 2-in SS  
**HAMMER TYPE:** Automatic  
**EFFICIENCY:** 85%  

**STANDARD PENETRATION TEST DATA**

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Depth (feet)</th>
<th>Recovery (inches)</th>
<th>Graphic Log</th>
<th>Sample Type</th>
<th>USCS Classification</th>
<th>SPT Blow per 6-inch</th>
<th>Standard Penetration Test Data</th>
<th>Moisture, %</th>
<th>Additional Remarks</th>
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<td>Orange and Gray,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>WELL- GRADED SAND</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>WITH CLAY AND GRAVEL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>20</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>6</td>
<td>25</td>
<td>18</td>
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</tr>
</tbody>
</table>

**LOCATION:** Wayne Ave and Watervliet, Dayton, Ohio  
**ELEVATION:** N/A  
**LATITUDE:** 39.738472°  
**LONGITUDE:** 84.152031°  

**LATITUDE:** 39.738472°  
**LONGITUDE:** 84.152031°  

---

**Additional Information:**
- **Cave Depth:** 13.5 feet
- **While Drilling:** N/A feet  
- **Upon Completion:** N/A feet

---

**REMARKS:**
- The stratification lines represent approximate boundaries. The transition may be gradual.

---

**PROJECT NO.:** 01051073  
**PROJECT:** DML Southeast Branch  
**LOCATION:** Wayne Ave and Watervliet, Dayton, Ohio  
**DATE STARTED:** 1/16/17  
**DATE COMPLETED:** 1/16/17  
**SPT Blows per 6-inch (SS):**
- 5-7-6 N=18  
- 3-4-5 N=13  
- 8-20-19 N=55  
- 6-8-10 N=25  
- 9-11-19 N=42  
- 18-22-33 N=78  
- 35-29-31 N=85  

---

**PROJECT COMPANY:** Professional Service Industries, Inc.
5599 Webster Street
Dayton, OH 45414
Telephone: (937) 898-1200
**DATE STARTED:** 1/16/17  
**DATE COMPLETED:** 1/16/17  
**COMPLETION DEPTH:** 10.0 ft  
**BENCHMARK:** N/A  
**ELEVATION:** N/A  
**LATITUDE:** 39.738417°  
**LONGITUDE:** 84.151758°  
**STATION:** N/A  
**OFFSET:** N/A  

**MATERIAL DESCRIPTION**

<table>
<thead>
<tr>
<th>Elevation (feet)</th>
<th>Depth, (feet)</th>
<th>Graphic Log</th>
<th>Sample Type</th>
<th>Sample No.</th>
<th>Recovery (inches)</th>
<th>USCS Classification</th>
<th>SPT Blows per 6-inch (SS)</th>
<th>Moisture, %</th>
<th>Additional Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td>1</td>
<td>12</td>
<td>TOPSOIL (4&quot;)</td>
<td>3-4-7</td>
<td>N\textsubscript{60}=16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td>2</td>
<td>18</td>
<td></td>
<td>5-6-7</td>
<td>N\textsubscript{60}=18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td>3</td>
<td>18</td>
<td>CLAYEY SAND</td>
<td>9-10-19</td>
<td>N\textsubscript{60}=41</td>
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</tr>
<tr>
<td></td>
<td>4</td>
<td></td>
<td></td>
<td>4</td>
<td>18</td>
<td>POORLY GRADED SAND</td>
<td>9-12-15</td>
<td>N\textsubscript{60}=38</td>
<td></td>
</tr>
</tbody>
</table>

End of boring, 10'

**LOCATION:** Wayne Ave and Watervliet

**LATITUDE:** 39.738417°  
**LONGITUDE:** 84.151758°  

**REMARKS:** N\textsubscript{60} denotes the normalization to 60% efficiency as described in ASTM D4633.
**DATE STARTED:** 1/16/17  
**DATE COMPLETED:** 1/16/17  
**COMPLETION DEPTH:** 10.0 ft  
**BENCHMARK:** N/A  
**ELEVATION:** N/A  
**LATITUDE:** 39.738192°  
**LONGITUDE:** 84.152378°  
**STATION:** N/A  
**OFFSET:** N/A  
**REMARKS:** N<sub>60</sub> denotes the normalization to 60% efficiency as described in ASTM D4633.

---

### Topsoil (4")

- **Sample Type:** CLS
- **Sample No.:** 3-8-8
- **N<sub>60</sub> = 23**
- **USCS Classification:** Qp
- **Additional Remarks:** Hard to Very Stiff, Damp to Moist, Brown, SANDY LEAN CLAY

### Medium Dense, Damp, Brown, POORLY GRADED SAND

- **Sample Type:** SP
- **Sample No.:** 3-4-4
- **N<sub>60</sub> = 11**

---

### Standard Penetration Test Data

<table>
<thead>
<tr>
<th>N in blows/ft</th>
<th>Moisture</th>
<th>LL</th>
<th>PL</th>
<th>Fines%</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-8-8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-6-7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-4-4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-5-7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**DRILL COMPANY:** Central Star  
**DRILLER:** TS  
**LOGGED BY:** DR  
**LATITUDE:** 39.738192°  
**LONGITUDE:** 84.152378°  
**LOCATION:** Wayne Ave and Watervliet  
**DATE STARTED:** 1/16/17  
**DATE COMPLETED:** 1/16/17  
**COORDINATES:** N/A  
**BENCHMARK:** N/A  
**ELEVATION:** N/A  
**LATITUDE:** 39.738192°  
**LONGITUDE:** 84.152378°  
**STATION:** N/A  
**OFFSET:** N/A  
**REMARKS:** N<sub>60</sub> denotes the normalization to 60% efficiency as described in ASTM D4633.
### Atterberg Limit Results

<table>
<thead>
<tr>
<th>Boring</th>
<th>Depth (ft)</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
<th>Fines</th>
<th>Classification (*Visual)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• B-1</td>
<td>6.8</td>
<td>44</td>
<td>20</td>
<td>24</td>
<td>56.8</td>
<td>SANDY LEAN CLAY (CLS)</td>
</tr>
<tr>
<td>□ B-3</td>
<td>1.8</td>
<td>35</td>
<td>17</td>
<td>18</td>
<td>43.2</td>
<td>CLAYEY SAND w GRAVEL (SC)</td>
</tr>
<tr>
<td>▲ B-8</td>
<td>4.3</td>
<td>45</td>
<td>20</td>
<td>25</td>
<td>61.1</td>
<td>SANDY LEAN CLAY (CLS)</td>
</tr>
</tbody>
</table>
### GRAIN SIZE DISTRIBUTION

**Specimen Identification**

<table>
<thead>
<tr>
<th>Specimen Identification</th>
<th>Classification</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
<th>Cc</th>
<th>Cu</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
<td>SANDY LEAN CLAY (CLS)</td>
<td>6.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B-3</td>
<td>CLAYEY SAND w GRAVEL (SC)</td>
<td>1.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B-4</td>
<td>WELL GRADED SAND w CLAY and GRAVEL (SW-SC)</td>
<td>19.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B-6</td>
<td>SANDY LEAN CLAY (CLS)</td>
<td>9.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B-8</td>
<td>SANDY LEAN CLAY (CLS)</td>
<td>4.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Specimen Identification**

<table>
<thead>
<tr>
<th>Specimen Identification</th>
<th>D100</th>
<th>D60</th>
<th>D30</th>
<th>D10</th>
<th>%Gravel</th>
<th>%Sand</th>
<th>%Silt</th>
<th>%Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
<td>6.8</td>
<td>9.5</td>
<td>0.101</td>
<td></td>
<td>0.8</td>
<td>42.4</td>
<td></td>
<td>56.8</td>
</tr>
<tr>
<td>B-3</td>
<td>1.8</td>
<td>19</td>
<td>0.42</td>
<td></td>
<td>24.6</td>
<td>32.2</td>
<td></td>
<td>43.2</td>
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<tr>
<td>B-4</td>
<td>19.3</td>
<td>25</td>
<td>3.555</td>
<td>0.58</td>
<td>34.9</td>
<td>53.1</td>
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<td>12.1</td>
</tr>
<tr>
<td>B-6</td>
<td>9.3</td>
<td>4.75</td>
<td>0.191</td>
<td>0.082</td>
<td>0.0</td>
<td>72.7</td>
<td></td>
<td>27.3</td>
</tr>
<tr>
<td>B-8</td>
<td>4.3</td>
<td>9.5</td>
<td></td>
<td></td>
<td>0.7</td>
<td>38.2</td>
<td></td>
<td>61.1</td>
</tr>
</tbody>
</table>

**Project:** DML Southeast Branch  
**PSI Job No.:** 01051073  
**Location:** Wayne Ave and Watervliet, Dayton, Ohio
Design Maps Summary Report

User-Specified Input

**Report Title**  DML Segment 3 - Southeast Branch Library  

(which utilizes USGS hazard data available in 2002)

**Site Coordinates**  39.73865°N, 84.1526°W

**Site Soil Classification**  Site Class C – “Very Dense Soil and Soft Rock”

**Occupancy Category**  1/II/III

---

**USGS-Provided Output**

\[
\begin{align*}
S_s &= 0.185 \text{ g} & S_{sa} &= 0.222 \text{ g} & S_{dd} &= 0.148 \text{ g} \\
S_1 &= 0.069 \text{ g} & S_{1a} &= 0.117 \text{ g} & S_{1d} &= 0.078 \text{ g}
\end{align*}
\]

---

Although this information is a product of the U.S. Geological Survey, we provide no warranty, expressed or implied, as to the accuracy of the data contained therein. This tool is not a substitute for technical subject-matter knowledge.

Design Maps Detailed Report

2006/2009 International Building Code (39.73865°N, 84.1526°W)

Site Class C – “Very Dense Soil and Soft Rock”, Occupancy Category I/II/III

Section 1613.5.1 — Mapped acceleration parameters

Note: Maps in the 2006 and 2009 International Building Code are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 1613.5.3.

From **Figure 1613.5(1)** \[1\] \[S_s = 0.185 \text{ g}\]

From **Figure 1613.5(2)** \[2\] \[S_i = 0.069 \text{ g}\]

Section 1613.5.2 — Site class definitions

<table>
<thead>
<tr>
<th>SITE CLASS</th>
<th>SOIL PROFILE NAME</th>
<th>Soil shear wave velocity, $\bar{v}_s$ (ft/s)</th>
<th>Standard penetration resistance, $\bar{N}$</th>
<th>Soil undrained shear strength, $s_u$ (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Hard rock</td>
<td>$\bar{v}_s &gt; 5,000$</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>B</td>
<td>Rock</td>
<td>$2,500 &lt; \bar{v}_s \leq 5,000$</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>C</td>
<td>Very dense soil and soft rock</td>
<td>$1,200 &lt; \bar{v}_s \leq 2,500$</td>
<td>$\bar{N} &gt; 50$</td>
<td>&gt;2,000 psf</td>
</tr>
<tr>
<td>D</td>
<td>Stiff soil profile</td>
<td>$600 \leq \bar{v}_s &lt; 1,200$</td>
<td>$15 \leq \bar{N} \leq 50$</td>
<td>1,000 to 2,000 psf</td>
</tr>
<tr>
<td>E</td>
<td>Stiff soil profile</td>
<td>$\bar{v}_s &lt; 600$</td>
<td>$\bar{N} &lt; 15$</td>
<td>&lt;1,000 psf</td>
</tr>
<tr>
<td>E</td>
<td>—</td>
<td>Any profile with more than 10 ft of soil having the characteristics:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1. Plasticity index $PI &gt; 20$,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Moisture content $w \geq 40%$, and</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Undrained shear strength $\bar{s}_u &lt; 500$ psf</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>—</td>
<td>Any profile containing soils having one or more of the following characteristics:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1. Soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Peats and/or highly organic clays ($H &gt; 10$ feet of peat and/or highly organic clay where $H =$ thickness of soil)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Very high plasticity clays ($H &gt; 25$ feet with plasticity index $PI &gt; 75$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Very thick soft/medium stiff clays ($H &gt; 120$ feet)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 1613.5.3 — Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters

### TABLE 1613.5.3(1)
VALUES OF SITE COEFFICIENT $F_s$

<table>
<thead>
<tr>
<th>Site Class</th>
<th>Mapped Spectral Response Acceleration at Short Period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$S_s \leq 0.25$</td>
</tr>
<tr>
<td>A</td>
<td>0.8</td>
</tr>
<tr>
<td>B</td>
<td>1.0</td>
</tr>
<tr>
<td>C</td>
<td>1.2</td>
</tr>
<tr>
<td>D</td>
<td>1.6</td>
</tr>
<tr>
<td>E</td>
<td>2.5</td>
</tr>
<tr>
<td>F</td>
<td>See Section 11.4.7 of ASCE 7</td>
</tr>
</tbody>
</table>

Note: Use straight–line interpolation for intermediate values of $S_s$

**For Site Class = C and $S_s = 0.185$ g, $F_s = 1.200$**

### TABLE 1613.5.3(2)
VALUES OF SITE COEFFICIENT $F_v$

<table>
<thead>
<tr>
<th>Site Class</th>
<th>Mapped Spectral Response Acceleration at 1–s Period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$S_1 \leq 0.10$</td>
</tr>
<tr>
<td>A</td>
<td>0.8</td>
</tr>
<tr>
<td>B</td>
<td>1.0</td>
</tr>
<tr>
<td>C</td>
<td>1.7</td>
</tr>
<tr>
<td>D</td>
<td>2.4</td>
</tr>
<tr>
<td>E</td>
<td>3.5</td>
</tr>
<tr>
<td>F</td>
<td>See Section 11.4.7 of ASCE 7</td>
</tr>
</tbody>
</table>

Note: Use straight–line interpolation for intermediate values of $S_1$

**For Site Class = C and $S_1 = 0.069$ g, $F_v = 1.700$**
In the equations below, the equation number corresponding to the 2006 edition is listed first, and that corresponding to the 2009 edition is listed second.

**Equation (16-37; 16-36):**  
\[ S_{NS} = F_s S_s = 1.200 \times 0.185 = 0.222 \text{ g} \]

**Equation (16-38; 16-37):**  
\[ S_{HI} = F_s S_1 = 1.700 \times 0.069 = 0.117 \text{ g} \]

Section 1613.5.4 — Design spectral response acceleration parameters

**Equation (16-39; 16-38):**  
\[ S_{DS} = \frac{2}{3} S_{NS} = \frac{2}{3} \times 0.222 = 0.148 \text{ g} \]

**Equation (16-40; 16-39):**  
\[ S_{DI} = \frac{2}{3} S_{HI} = \frac{2}{3} \times 0.117 = 0.078 \text{ g} \]
Section 1613.5.6 — Determination of seismic design category

TABLE 1613.5.6(1)
SEISMIC DESIGN CATEGORY BASED ON SHORT-PERIOD RESPONSE ACCELERATION

<table>
<thead>
<tr>
<th>VALUE OF S_{0s}</th>
<th>OCCUPANCY CATEGORY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I or II</td>
</tr>
<tr>
<td>S_{0s} &lt; 0.167g</td>
<td>A</td>
</tr>
<tr>
<td>0.167g \leq S_{0s} &lt; 0.33g</td>
<td>B</td>
</tr>
<tr>
<td>0.33g \leq S_{0s} &lt; 0.50g</td>
<td>C</td>
</tr>
<tr>
<td>0.50g \leq S_{0s}</td>
<td>D</td>
</tr>
</tbody>
</table>

For Occupancy Category = I and S_{0s} = 0.148 g, Seismic Design Category = A

TABLE 1613.5.6(2)
SEISMIC DESIGN CATEGORY BASED ON 1-SECOND PERIOD RESPONSE ACCELERATION

<table>
<thead>
<tr>
<th>VALUE OF S_{01}</th>
<th>OCCUPANCY CATEGORY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I or II</td>
</tr>
<tr>
<td>S_{01} &lt; 0.067g</td>
<td>A</td>
</tr>
<tr>
<td>0.067g \leq S_{01} &lt; 0.133g</td>
<td>B</td>
</tr>
<tr>
<td>0.133g \leq S_{01} &lt; 0.20g</td>
<td>C</td>
</tr>
<tr>
<td>0.20g \leq S_{01}</td>
<td>D</td>
</tr>
</tbody>
</table>

For Occupancy Category = I and S_{01} = 0.078 g, Seismic Design Category = B

Note: When S_{0} is greater than or equal to 0.75g, the Seismic Design Category is E for buildings in Occupancy Categories I, II, and III, and F for those in Occupancy Category IV, irrespective of the above.

Seismic Design Category ≡ “the more severe design category in accordance with Table 1613.5.6(1) or 1613.5.6(2)” = B

Note: See Section 1613.5.6.1 for alternative approaches to calculating Seismic Design Category.

References

1. *Figure 1613.5(1)*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2006-Figure1613_5(01).pdf
2. *Figure 1613.5(2)*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2006-Figure1613_5(02).pdf
GENERAL NOTES

SAMPLE IDENTIFICATION

The Unified Soil Classification System (USCS), AASHTO 1988 and ASTM designations D2487 and D-2488 are used to identify the encountered materials unless otherwise noted. Coarse-grained soils are defined as having more than 50% of their dry weight retained on a #200 sieve (0.075mm); they are described as: boulders, cobbles, gravel or sand. Fine-grained soils have less than 50% of their dry weight retained on a #200 sieve; they are defined as silts or clay depending on their Atterberg Limit attributes. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size.

DRILLING AND SAMPLING SYMBOLS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFA</td>
<td>Solid Flight Auger - typically 4&quot; diameter flights, except where noted.</td>
</tr>
<tr>
<td>HSA</td>
<td>Hollow Stem Auger - typically ¾&quot; or ¾¼ I.D. openings, except where noted.</td>
</tr>
<tr>
<td>M.R.</td>
<td>Mud Rotary - Uses a rotary head with Bentonite or Polymer Slurry</td>
</tr>
<tr>
<td>R.C.</td>
<td>Diamond Bit Core Sampler</td>
</tr>
<tr>
<td>H.A.</td>
<td>Hand Auger</td>
</tr>
<tr>
<td>P.A.</td>
<td>Power Auger - Handheld motorized auger</td>
</tr>
</tbody>
</table>

RELATIVE DENSITY OF COARSE-GRAINED SOILS

<table>
<thead>
<tr>
<th>Relative Density</th>
<th>N - Blows/foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Loose</td>
<td>0 - 4</td>
</tr>
<tr>
<td>Loose</td>
<td>4 - 10</td>
</tr>
<tr>
<td>Medium Dense</td>
<td>10 - 30</td>
</tr>
<tr>
<td>Dense</td>
<td>30 - 50</td>
</tr>
<tr>
<td>Very Dense</td>
<td>50 - 80</td>
</tr>
<tr>
<td>Extremely Dense</td>
<td>80+</td>
</tr>
</tbody>
</table>

ANGULARITY OF COARSE-GRAINED PARTICLES

<table>
<thead>
<tr>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angular</td>
<td>Particles have sharp edges and relatively plane sides with unpolished surfaces</td>
</tr>
<tr>
<td>Subangular</td>
<td>Particles are similar to angular description, but have rounded edges</td>
</tr>
<tr>
<td>Subrounded</td>
<td>Particles have nearly plane sides, but have well-rounded corners and edges</td>
</tr>
<tr>
<td>Rounded</td>
<td>Particles have smoothly curved sides and no edges</td>
</tr>
</tbody>
</table>

GRAIN-SIZE TERMINOLOGY

<table>
<thead>
<tr>
<th>Component</th>
<th>Size Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulders</td>
<td>Over 300 mm (&gt;12 in.)</td>
</tr>
<tr>
<td>Cobbles</td>
<td>75 mm to 300 mm (3 in. to 12 in.)</td>
</tr>
<tr>
<td>Coarse-Grained Gravel</td>
<td>19 mm to 75 mm (¾ in. to 3 in.)</td>
</tr>
<tr>
<td>Fine-Grained Gravel</td>
<td>4.75 mm to 19 mm (No.4 to ¾ in.)</td>
</tr>
<tr>
<td>Coarse-Grained Sand</td>
<td>2 mm to 4.75 mm (No.10 to No.4)</td>
</tr>
<tr>
<td>Medium-Grained Sand</td>
<td>0.42 mm to 2 mm (No.40 to No.10)</td>
</tr>
<tr>
<td>Fine-Grained Sand</td>
<td>0.075 mm to 0.42 mm (No. 200 to No.40)</td>
</tr>
<tr>
<td>Silt</td>
<td>0.002 mm to 0.075 mm</td>
</tr>
<tr>
<td>Clay</td>
<td>&lt;0.002mm to &lt;0.005 mm depending on agency</td>
</tr>
</tbody>
</table>

PARTICLE SHAPE

<table>
<thead>
<tr>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat</td>
<td>Particles with width/thickness ratio &gt; 3</td>
</tr>
<tr>
<td>Elongated</td>
<td>Particles with length/width ratio &gt; 3</td>
</tr>
<tr>
<td>Flat &amp; Elongated</td>
<td>Particles meet criteria for both flat and elongated</td>
</tr>
</tbody>
</table>

RELATIVE PROPORTIONS OF FINES

<table>
<thead>
<tr>
<th>Descriptive Term</th>
<th>% Dry Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace:</td>
<td>&lt; 5%</td>
</tr>
<tr>
<td>With:</td>
<td>5% to 12%</td>
</tr>
<tr>
<td>Modifier:</td>
<td>&gt;12%</td>
</tr>
</tbody>
</table>
### Consistency of Fine-Grained Soils

<table>
<thead>
<tr>
<th>Q&lt;sub&gt;u&lt;/sub&gt; - TSF</th>
<th>N - Blows/foot</th>
<th>Consistency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.25</td>
<td>0 - 2</td>
<td>Very Soft</td>
</tr>
<tr>
<td>0.25 - 0.50</td>
<td>2 - 4</td>
<td>Soft</td>
</tr>
<tr>
<td>0.50 - 1.00</td>
<td>4 - 8</td>
<td>Firm (Medium Stiff)</td>
</tr>
<tr>
<td>1.00 - 2.00</td>
<td>8 - 15</td>
<td>Stiff</td>
</tr>
<tr>
<td>2.00 - 4.00</td>
<td>15 - 30</td>
<td>Very Stiff</td>
</tr>
<tr>
<td>4.00 - 8.00</td>
<td>30 - 50</td>
<td>Hard</td>
</tr>
<tr>
<td>8.00+</td>
<td>50+</td>
<td>Very Hard</td>
</tr>
</tbody>
</table>

### Moisture Condition Description

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td>Absence of moisture, dusty, dry to the touch</td>
</tr>
<tr>
<td>Wet</td>
<td>Visible free water, usually soil is below water table</td>
</tr>
<tr>
<td>Moist</td>
<td>Damp but no visible water</td>
</tr>
</tbody>
</table>

### Relative Proportions of Sand and Gravel

<table>
<thead>
<tr>
<th>Descriptive Term</th>
<th>% Dry Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace</td>
<td>&lt; 15%</td>
</tr>
<tr>
<td>With</td>
<td>15% to 30%</td>
</tr>
<tr>
<td>Modifier</td>
<td>&gt;30%</td>
</tr>
</tbody>
</table>

### Structure Description

- **Stratified**: Alternating layers of varying material or color with layers at least ¼-inch (6 mm) thick
- **Laminated**: Alternating layers of varying material or color with layers less than ¼-inch (6 mm) thick
- **Fissured**: Breaks along definite planes of fracture with little resistance to fracturing
- **Slickensided**: Fracture planes appear polished or glossy, sometimes striated

### Scale of Relative Rock Hardness

<table>
<thead>
<tr>
<th>Q&lt;sub&gt;u&lt;/sub&gt; - TSF</th>
<th>Consistency</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5 - 10</td>
<td>Extremely Soft</td>
</tr>
<tr>
<td>10 - 50</td>
<td>Very Soft</td>
</tr>
<tr>
<td>50 - 250</td>
<td>Soft</td>
</tr>
<tr>
<td>250 - 525</td>
<td>Medium Hard</td>
</tr>
<tr>
<td>525 - 1,050</td>
<td>Moderately Hard</td>
</tr>
<tr>
<td>1,050 - 2,600</td>
<td>Hard</td>
</tr>
<tr>
<td>&gt;2,600</td>
<td>Very Hard</td>
</tr>
</tbody>
</table>

### Rock Bedding Thicknesses

<table>
<thead>
<tr>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Thick Bedded</td>
<td>Greater than 3-foot (&gt;1.0 m)</td>
</tr>
<tr>
<td>Thick Bedded</td>
<td>1-foot to 3-foot (0.3 m to 1.0 m)</td>
</tr>
<tr>
<td>Medium Bedded</td>
<td>4-inch to 1-foot (0.1 m to 0.3 m)</td>
</tr>
<tr>
<td>Thin Bedded</td>
<td>1¼-inch to 4-inch (30 mm to 100 mm)</td>
</tr>
<tr>
<td>Very Thin Bedded</td>
<td>½-inch to 1¼-inch (10 mm to 30 mm)</td>
</tr>
<tr>
<td>Thickly Laminated</td>
<td>1/8-inch to ½-inch (3 mm to 10 mm)</td>
</tr>
<tr>
<td>Thinly Laminated</td>
<td>1/8-inch or less &quot;paper thin&quot; (&lt;3 mm)</td>
</tr>
</tbody>
</table>

### Rock Voids

<table>
<thead>
<tr>
<th>Voids</th>
<th>Void Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pit</td>
<td>&lt;6 mm (&lt;0.25 in)</td>
</tr>
<tr>
<td>Vug</td>
<td>6 mm to 50 mm (0.25 in to 2 in)</td>
</tr>
<tr>
<td>Cavity</td>
<td>50 mm to 600 mm (2 in to 24 in)</td>
</tr>
<tr>
<td>Cave</td>
<td>&gt;600 mm (&gt;24 in)</td>
</tr>
</tbody>
</table>

### Grain-Sized Terminology

<table>
<thead>
<tr>
<th>Component</th>
<th>Size Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Coarse Grained</td>
<td>&gt;4.76 mm</td>
</tr>
<tr>
<td>Coarse Grained</td>
<td>2.0 mm - 4.76 mm</td>
</tr>
<tr>
<td>Medium Grained</td>
<td>0.42 mm - 2.0 mm</td>
</tr>
<tr>
<td>Fine Grained</td>
<td>0.075 mm - 0.42 mm</td>
</tr>
<tr>
<td>Very Fine Grained</td>
<td>&lt;0.075 mm</td>
</tr>
</tbody>
</table>

### Rock Quality Description

<table>
<thead>
<tr>
<th>Rock Mass Description</th>
<th>RQD Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>90 - 100</td>
</tr>
<tr>
<td>Good</td>
<td>75 - 90</td>
</tr>
<tr>
<td>Fair</td>
<td>50 - 75</td>
</tr>
<tr>
<td>Poor</td>
<td>25 - 50</td>
</tr>
<tr>
<td>Very Poor</td>
<td>Less than 25</td>
</tr>
</tbody>
</table>

### Degree of Weathering

- **Slightly Weathered**: Rock generally fresh, joints stained and discoloration extends into rock up to 25 mm (1 in), open joints may contain clay, core rings under hammer impact.
- **Weathered**: Rock mass is decomposed 50% or less, significant portions of the rock show discoloration and weathering effects, cores cannot be broken by hand or scraped by knife.
- **Highly Weathered**: Rock mass is more than 50% decomposed, complete discoloration of rock fabric, core may be extremely broken and gives clunk sound when struck by hammer, may be shaved with a knife.
## SOIL CLASSIFICATION CHART

**FOOTNOTE:** DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

<table>
<thead>
<tr>
<th>MAJOR DIVISIONS</th>
<th>SYMBOLS</th>
<th>TYPICAL DESCRIPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COARSE GRAINED SOILS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRAVEL AND GRAVELLY SOILS</td>
<td>GW</td>
<td>WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES</td>
</tr>
<tr>
<td>(LITTLE OR NO FINES)</td>
<td>GP</td>
<td>POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES</td>
</tr>
<tr>
<td>GRAVELS WITH FINES</td>
<td>GM</td>
<td>SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES</td>
</tr>
<tr>
<td>(APPRECIABLE AMOUNT OF FINES)</td>
<td>GC</td>
<td>CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES</td>
</tr>
<tr>
<td>SAND AND SANDY SOILS</td>
<td>SW</td>
<td>WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES</td>
</tr>
<tr>
<td>(LITTLE OR NO FINES)</td>
<td>SP</td>
<td>POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES</td>
</tr>
<tr>
<td>SANDS WITH FINES</td>
<td>SM</td>
<td>SILTY Sands, SAND - SILT MIXTURES</td>
</tr>
<tr>
<td>(APPRECIABLE AMOUNT OF FINES)</td>
<td>SC</td>
<td>CLAYEY SANDS, SAND - CLAY MIXTURES</td>
</tr>
<tr>
<td><strong>FINE GRAINED SOILS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SILTS AND CLAYS</td>
<td>ML</td>
<td>INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY</td>
</tr>
<tr>
<td>LIQUID LIMIT LESS THAN 50</td>
<td>CL</td>
<td>INORGANIC ClAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS</td>
</tr>
<tr>
<td>OL</td>
<td>ORGANIC SILTS AND ORGANIC SILT CLAYS OF LOW PLASTICITY</td>
<td></td>
</tr>
<tr>
<td>SILTS AND CLAYS</td>
<td>MH</td>
<td>INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS</td>
</tr>
<tr>
<td>LIQUID LIMIT GREATER THAN 50</td>
<td>CH</td>
<td>INORGANIC ClAYS OF HIGH PLASTICITY</td>
</tr>
<tr>
<td>OH</td>
<td>ORGANIC ClAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS</td>
<td></td>
</tr>
<tr>
<td><strong>HIGHLY ORGANIC SOILS</strong></td>
<td>PT</td>
<td>PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS</td>
</tr>
</tbody>
</table>
NO SMOKING

To report violations call 866-559-OHIO (6446) in accordance with Chapter 3794 of the Ohio Revised Code.
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for unit prices.

B. Related Sections include the following:
   1. TAB 2 – Scope of Work.
   2. TAB 6 - Bid Form

1.3 DEFINITIONS

A. Unit price is an amount proposed by bidders, stated on the Unit Price Form, as a price per unit of measurement for materials or services added to or deducted from the Contract Sum by appropriate modification, if estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROCEDURES

A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.

B. Measurement and Payment: Refer to individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.

C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.

D. List of Unit Prices: A list of unit prices, if requested, is included on the Bid Form. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012200
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for handling and processing Contract modifications.

B. Related Sections include the following:
1. Division 01 Section "Allowances" for procedural requirements for handling and processing allowances.
2. Division 01 Section "Unit Prices" for administrative requirements for using unit prices.
3. Division 01 Section "Product Requirements" for administrative procedures for handling requests for substitutions made after Contract award.

1.3 CHANGES IN THE WORK

A. Depending on the cost of the change and the urgency, the change must follow one of three paths:
1. A Field Work Order is executed.
2. A fully signed Change Order is executed.
3. Or an authorized letter/email from Construction Manager is issued.

1.4 PROPOSAL REQUESTS

A. Owner-Initiated Bulletins: Construction Manager will issue, as prepared by the Architect, a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
1. Bulletins issued by Architect or Construction Manager are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.
2. Within 10 days after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change. If quotation estimating costs are not received within the 10 days, that Proposal Request may be rejected by the Architect or Construction Manager.
   a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
   b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
   c. Include costs of labor and supervision directly attributable to the change. All rates must match the certified payroll rates.
   d. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
   e. Overhead and profit credits are to be included as they apply.

B. Contractor-Initiated Proposals: If latent or unforeseen conditions require modifications to the Contract, Contractor may propose changes by submitting a request for a change to Construction Manager.
1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.

2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.

3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.

4. Include costs of labor and supervision directly attributable to the change.

5. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

6. Comply with requirements in Division 01 Section "Product Requirements" if the proposed change requires substitution of one product or system for product or system specified.

C. Proposal Request Form: Sample copy is included.

1.5 ALLOWANCES

A. Allowance Adjustment: To adjust allowance amounts, base each Change Order proposal on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.

1. Include installation costs in purchase amount only where indicated as part of the allowance.

2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.

3. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.

B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the Purchase Order amount or Contractor's handling, labor, installation, overhead, and profit. Submit claims within 10 days of receipt of the Change Order or Construction Change Directive authorizing work to proceed. Owner will reject claims submitted later than 10 days after such authorization.

1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of work has changed from what could have been foreseen from information in the Contract Documents.

2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

1.6 CHANGE ORDER PROCEDURES

A. On Owner's approval of a Request for Change, Construction Manager will issue a Change Order or Field Work Order for signatures of Construction Manager, A/E, Owner, and Contractor on form included at end of Part 3.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.
   1. Coordinate the Contract Cost Breakdown with the Applications for Payment, Project Schedule, Submittal Schedule, and List of Subcontracts.
   2. Progress payments will not be processed without an approved Contract Cost Breakdown on file.
   3. Contractors shall use form provided.
   4. LEED breakouts will be required for the certification process and must be included.

B. Related Sections include the following:
   1. Division 01 Section "Allowances" for procedural requirements governing handling and processing of allowances.
   2. Division 01 Section "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
   3. Division 01 Section "Unit Prices" for administrative requirements governing use of unit prices.
   4. Division 01 Section "Construction Progress Documentation" for administrative requirements governing preparation and submittal of Contractor's Construction Schedule and Submittals Schedule.

1.3 CONTRACT COST BREAKDOWN

A. Coordination: Each Prime Contractor shall coordinate preparation of their Contract Cost Breakdown for its part of the work with the Construction Schedule and receive an approval sign-off by the A/E, through the Construction Manager.
   1. Correlate line items in the Contract Cost Breakdown with other required administrative forms and schedules, including the following:
      a. Application for Payment forms with Continuation Sheets.
      b. Submittals Schedule.
      c. Construction Schedule.
      d. List of subcontractors.
      e. Schedule of allowances.
      f. Schedule of alternates.
      g. List of LEED associated costs.
      h. List of products.
      i. List of LEED associated products.
      j. List of principal suppliers and fabricators.
   2. Submit the Contract Cost Breakdown to A/E through Construction Manager at earliest possible date but no later than 15 days before the date scheduled for submittal of initial Applications for Payment.
   3. Documentation required to complete LEED certification and requested from the contractor.
   4. This is a prevailing wage and certified payroll project.

B. Format and Content: Use the Project Manual table of contents as a guide to establish the format for the Contract Cost Breakdown. The Contract Cost Breakdown shall include at a minimum a line item for labor and material costs for each specification section assigned to the Contractor and shall further divide the work into a sufficient number of individual work items to serve as an accurate basis for Contractor’s Application for Payment. Each work item shall receive its
prorated share of profit and overhead. Separate items shall not be shown for overhead or profit, but shall be included in the totals for labor and materials. The Contract Cost Breakdown shall consist of a complete breakdown of the Contractor’s contract sum showing the various items of work, divided so as to facilitate the approval of payments to the Contractor for Work completed. In addition to and conjunctive with the division of various items of work, the breakdown shall separate units within the project, shall separate sitework from building(s) components, and shall separate remodeling/renovation work from new construction work. The Contract Cost Breakdown shall be prepared in a format as directed by the Architect and Construction Manager, showing the breakdown of items of Work and supported by such data to substantiate its correctness as the Architect and Construction Manager may require. The contract breakdown shall be the same form as that to be used in submitting request for payments. Each item of Work shall have indicated a separate cost of labor and material. This schedule when reviewed by the Architect, Construction Manager, and Owner shall be used as the basis of approving payments along with establishing percentages of Work complete.

1. Identification: Include the following Project identification on the Contract Cost Breakdown:
   a. Project name and location.
   b. Name of Construction Manager.
   c. Name of the Architect.
   d. Project number.
   e. Contractor’s name and address.
   f. Date of submittal and signature.
   g. Bid Category.

2. Arrange the Contract Cost Breakdown in tabular form with separate columns to indicate the following for each item listed or match a form layout agreed upon by the A/E and CM.
   a. Related Specification Section or Division.
   b. Description of Work.
   c. Name of subcontractor.
   d. Name of manufacturer or fabricator.
   e. Name of supplier.
   f. Change Orders (numbers) that affect value.
   g. Dollar value.
   h. Percentage of Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.

3. In addition to the sections assigned to the Contractor as defined above, Contractors shall include the following line items on their Schedule of Values:
   a. Bonds: Performance, Labor and Material (if required).
   b. Mobilization, including permits.
   c. Demobilization.
   d. Insurance/Hazcom/Safety.
   e. Submittals in the amount of 2 percent of the Contract; however, not less than $1,000.00 or more than $15,000.00.
   f. Project Meetings in the amount of $250.00 times the anticipated number of meetings the Contractor will be required to attend during the course of the Project.
   g. Daily and final cleanup (in the amount of 1 percent of the total contract amount). Daily cleanup shall be 80 percent of total with remainder held for final cleanup.
   h. Punch lists in the amount of 2 percent of the Contract; however, not less than $1,000.00 minimum and $50,000.00 maximum.
   i. Closeout in an amount equal to 2 percent of the Contract amount; however, not less than $500.00 or more than $50,000.00.
   j. HVAC testing/adjusting/balancing.
   k. Allowances.
   l. LEED
   m. Cx
4. Provide a breakdown of the Contract Sum in sufficient detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Break principal subcontract amounts down into several line items. Contract Cost Breakdown shall be coordinated with the Construction Schedules such that the percentages of Work completed closely relates to the values for the Work shown on the request for payments. At the beginning of the Project, the Contractor shall prepare a schedule of monthly progress payments showing the amount the Contractor may require for the Work proposed to be completed. The purpose of this schedule is to allow the Owner to determine what amounts of funds will be required to have available each month during the progress of construction for progress payments.
   a. Whenever the material allocation exceeds 55 percent of the Contract price, the Contractor shall provide, upon request, sufficient information to support such higher percentage.

5. Round amounts to nearest whole dollar. The total shall equal the Contract Sum.

6. Provide a separate line item in the Contract Cost Breakdown for each part of the Work where Applications for Payment may include materials or equipment, purchased or fabricated and stored, but not yet installed.
   a. Differentiate between items stored on-site and items stored off-site. Include requirements for insurance and bonded warehousing, if required.

7. Provide separate line items on the Contract Cost Breakdown for initial cost of the materials, for each subsequent stage of completion, and for total installed value of that part of the Work.

8. Margins of Cost: Show line items for indirect costs and margins on actual costs only when such items are listed individually in Applications for Payment. Each item in the Contract Cost Breakdown and Applications for Payment shall be complete. Include the total cost and proportionate share of general overhead and profit margin for each item.
   a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Contract Cost Breakdown or distributed as general overhead expense, at the Contractor’s option, unless otherwise noted herein before.

9. Schedule Updating: Update and resubmit the Contract Cost Breakdown prior to the next Applications for Payment when Work Orders, Change Orders, or Authorization Letters result in a change in the Contract Sum.

C. Contract Cost Breakdown shall be typed or printed on attached forms.

D. Should the Contract Cost Breakdown be “rejected, resubmit”, resubmittal is due within 5 days of receipt of rejected schedule.

E. After approval by Architect and Construction Manager, no changes permitted to the Contract Cost Breakdown. Add approved Change Orders and Construction Change Directives are to be logged at end of schedule.

F. All contractors are responsible for submitting all required documentation required by the Responsible Bidder language adopted by the district. Certified Payroll documentation will be required, as applicable for contracts, with payment applications.

1.4 APPLICATIONS FOR PAYMENT

A. The Application and Certification for Payment, including progress payments shall be as indicated in the Agreement (Contract) between Owner and Contractor. Payments to the Contractor will not be made until final approval by the Owner and submittals that precede application have been received and accepted as identified herein. The Contractor shall submit to the Construction Manager, 4 copies, an itemized Application for Payment, supported by such data, such invoices, substantiating the Contractor’s right to payment as the Construction Manager, Owner, or Architect may require. The form of Application and Certification for Payment shall be enclosed herein.

1. Contractors shall prepare a pencil copy of the Application and Certification for Payment to the Construction Manager electronically and follow the pay application schedule provided.
B. Each Application for Payment shall be consistent with previous applications and payments as observed by the Construction Manager and Architect and paid for by the Owner.

C. Application Preparation: Complete every entry on the form. Include notarization and execution by a person authorized to sign legal documents on behalf of the Contractor. The Construction Manager will return incomplete applications without action.
   1. Entries shall match data on the Contract Cost Breakdown and the Construction Schedule. Use updated schedules, if revisions were made. The original Schedule of Values is not to be altered.
   2. Include amounts of fully executed Work Orders, fully executed Change Orders, and fully executed Authorization Letters issued prior to the last day of the construction period covered by the application.
   3. Contractor’s application for payment shall reflect an equal percentage amount for labor and materials for Work completed. The Construction Manager or Architect may adjust applications where labor exceeds materials or where materials exceed labor quantities in the Work completed columns."

D. Transmittal: Submit 4 signed and notarized original copies of each Application for Payment to the Construction Manager by a method ensuring receipt within 24 hours. One copy shall be complete, including waivers of lien and similar attachments, when required.
   1. Transmit each copy with a transmittal form listing attachments and recording appropriate information related to the application, in a manner acceptable to the Construction Manager.

E. All contractors are responsible for submitting all required documentation required by the Responsible Bidder language adopted by the district. Certified Payroll documentation will be required, as applicable for contracts, with payment applications. This is a prevailing wage project. Electronic certified payroll is acceptable.

F. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of the first Application for Payment include the following:
   1. Contract Cost Breakdown must be both submitted and accepted. (Schedule of Values)
   2. Construction Schedule.
   3. Submittal Schedule must be submitted and coordinated with Project Schedule.
   5. Copies of authorizations and licenses from governing authorities for performance of the Work.
   6. Initial progress report.
   8. Certificates of insurance and insurance policies.

G. Final Payment Application: Administrative actions and submittals that must precede or coincide with submittal of the final Application for Payment include the following:
   1. Completion of Project closeout requirements.
   3. Affidavit of Contractor.
   4. Receipt of spare parts, tools, maintenance equipment, and attic stock.
   5. Certificate of Completion of Owner training.
   6. Valve chart/concealed items schedule.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012900
Contractor's Name:  
Address:  

**Contractor Pay Application Summary**

**Project Name**
**Bid Package No.**

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<tr>
<th></th>
<th>Description</th>
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<tr>
<td>1</td>
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APPLICATION AND CERTIFICATE FOR PAYMENT

TO OWNER: 

FROM CONTRACTOR: 

PROJECT: 

APPLICATION No:

PERIOD TO:

PROJECT NOS:

CONTRACT DATE:

VIA ARCHITECT:

CONTRACT FOR:

CONTRACTOR'S APPLICATION FOR PAYMENT

Application is made for payment as shown below, in connection with the Contract work covered by all prior pay requests. Continuation sheet is attached.

1. ORIGINAL CONTRACT SUM.............................
2. Net Change by Change Orders........................ $0.00
3. CONTRACT SUM TO DATE.............................. $0.00
4. TOTAL COMPLETED & STORED TO DATE............. $0.00
5. RETAINAGE
   a. 8-50% of Completed Labor............. #DIV/0!
   b. 8% of Stored Material.................. $0.00
   Total Retainage.................................... #DIV/0!
6. TOTAL EARNED LESS RETAINAGE..................... #DIV/0!
7. LESS PREVIOUS CERTIFICATES FOR PAYMENT.....
8. CURRENT PAYMENT DUE............................... #DIV/0!
9. BALANCE TO FINISH, INCLUDING RETAINAGE....... #DIV/0!

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<th>Change Order/Contract</th>
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<td>NET CHANGES by Change Order</td>
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The Contractor certified that the work covered by this pay request has been completed in accordance with the Contract Documents and that all progress payments previously paid by the State have been applied by the Contractor to discharge in full all of Contractor's obligations incurred in connection with the work covered by all prior pay requests.

Contractor Date

Based upon on-site observations, the firm affirms that the work has progressed to the percentage of completeness indicated on the pay request.

Architect Date

Construction Manager Date

Approved:

School District Treasurer Date
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<tr>
<th>Employee Name, Address</th>
<th>Work Class 3</th>
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<th>Hours Worked - Day &amp; Date</th>
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<th>Base Rate</th>
<th>Fringes:</th>
<th>Cash</th>
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By signing below, I certify that: (1) I pay, or supervise the payment of the employees shown above; (2) during the pay period reported on this form, all hours worked on this project have been paid at the appropriate prevailing wage rate for the class of work done, if applicable; (3) the fringe benefits have been paid as indicated above; (4) no rebates or deductions have been or will be made, directly or indirectly from the total wages earned, other than permissible deductions as defined in ORC Chapter 4115; and (5) apprentices are registered with the U.S. Dept. of Labor, Bureau of Apprenticeship and Training. I understand that the willful falsification of any of the above statements may subject the Contractor or Subcontractor to civil or criminal prosecution.

Type or Print Name and Title __________________________ Signature __________________________ Date ____________

---

1 If Subcontractor, provide Contractor name in space provided.  
2 Attach additional sheets as necessary.  
3 Type in continuous line, text will wrap.
SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
1. Coordination Drawings.
2. Administrative and supervisory personnel.
3. Project meetings/conferences.
   a. Pre-construction conference.
   b. Pre-installation conference.
   c. Progress meetings.
   d. Coordination meetings.
   e. Pre-closeout meeting.
4. Requests for Interpretation (RFIs).

B. Related Sections include the following:
1. Division 01 Section "Construction Progress Documentation" for preparing and submitting Contractor's Construction Schedule.
2. Division 01 Section "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
3. Division 01 Section "Closeout Procedures" for coordinating closeout of the Contract.

C. Each contractor shall participate in coordination requirements.
1. Certain areas of responsibility will be assigned to a specific contractor. Each Contractor is responsible to coordinate their Work with the Work of other trades and other Contractors and requirements of the school system through the Construction Manager.
2. Each Contractor must make space allowances for Work of other Contractors and provide necessary openings where indicated or implied by the Contract Documents, and per the supervision/coordination of all trades.
3. The phasing plans shall be planned and executed in accordance with the Contract Documents. The Construction Manager shall monitor and adjust, with input by all contractors, the Schedule as necessary to complete the work. The Contractors shall provide sufficient staffing, materials and equipment to perform the work within the Schedule.

D. Each Contractor or awardee shall be required to have present at each project meeting a representative, with signatory authority, acceptable to the Construction Manager and A/E. The designated representative shall have sufficient authority and knowledge to make decisions for the Contractor he is representing on matters affecting this Project.
1. Contractor or representative unable to attend a specified meeting shall have an acceptable alternate representative designated or shall notify, in writing, the Construction Manager and A/E not less than 3 days prior to date of meeting.

1.3 DEFINITIONS

A. Request for Interpretation (RFI): A request for a prime contractor seeking an interpretation or a clarification of some requirement of the Contract Documents. The contractor shall clearly and concisely set forth the issue for which it seeks clarification or interpretation and why a response
is needed. The contractor shall, using the required Prolog Web program, set forth its interpretation or understanding of the contract's requirements along with reasons why it has reached such an understanding and recommendations for a solution. Responses will not change any requirements of the Contract Documents.

B. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.

1.4 COORDINATION

A. Coordination: Each contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each contractor shall coordinate its operations with operations, included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.
4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.

B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's Construction Schedule.
2. Preparation of the Schedule of Values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Provide weekly meeting trailer and lead the meeting. Include any subcontractors whose scope or coordination of work may be discussed.
7. Pre-installation conferences.
8. Project closeout activities.
9. Startup and adjustment of systems.

D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. Refer to other Sections for disposition of salvaged materials that are designated as Owner's property.

1.5 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

A. General: In addition to Project superintendent, provide other administrative and supervisory personnel as required for proper performance of the Work.

1. Include special personnel required for coordination of operations with other contractors.
1.6 PROJECT MEETINGS

A. General: The Construction Manager will schedule and conduct meetings and conferences at Project site, unless otherwise indicated. Any Contractor who fails to attend a meeting without prior written approval from the Construction Manager will not be paid, per their schedule of values, for any missed meetings.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times. Progress Meetings are to be attended by ALL subs that have work scheduled within 3 weeks of the meeting. They are to attend until all scope is complete. GC will be charged $250 per subcontractor per meeting that does not attend. Person attending the meeting must be able to make decisions on the company’s behalf. i.e. Costs, Manpower, Schedule, etc.

2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.

3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within 3 days of the meeting.

B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner, Construction Manager, and Architect, but no later than 15 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.

1. Attendees: Authorized representatives of Owner, Construction Manager, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.

2. Agenda: Discuss items of significance that could affect progress, including the following:
   a. Tentative construction schedule.
   b. Phasing, if applicable.
   c. Critical work sequencing and long-lead items.
   d. Designation of key personnel and their duties.
   e. Procedures for processing field decisions and Change Orders.
   f. Procedures for RFIs.
   g. Procedures for testing and inspecting.
   h. Procedures for processing Applications for Payment.
   i. Distribution of the Contract Documents.
   j. Submittal procedures.
   k. LEED requirements or other sustainable design requirements.
   l. Preparation of Record Documents.
   m. Use of the premises and/or existing building.
   n. Work restrictions.
   o. Owner’s occupancy requirements.
   p. Responsibility for temporary facilities and controls.
   q. Construction waste management and recycling, if applicable.
   r. Parking availability.
   s. Office, work, and storage areas.
   t. Equipment deliveries and priorities.
   u. First aid.
   w. Progress cleaning.
   x. Working hours.

3. Minutes: GC should record and distribute meeting minutes.

C. Pre-installation Conferences: The contractor shall conduct a pre-installation conference at Project site before each construction activity that requires coordination with other construction and as indicated in the Contract Documents.
1. **Attendees**: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect and Construction Manager of scheduled meeting dates a minimum of 1 week in advance.

2. **Agenda**: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
   b. Options.
   c. Related RFIs.
   d. Related Change Orders.
   e. Purchases.
   f. Deliveries.
   g. Submittals.
   h. Review of mockups.
   i. Possible conflicts.
   j. Compatibility problems.
   k. Time schedules.
   l. Weather limitations.
   m. Manufacturer's written recommendations.
   n. Warranty requirements.
   o. Compatibility of materials.
   p. Acceptability of substrates.
   q. Temporary facilities and controls.
   r. Space and access limitations.
   s. Regulations of authorities having jurisdiction.
   t. Testing and inspecting requirements.
   u. Installation procedures.
   v. Coordination with other work.
   w. Required performance results.
   x. Protection of adjacent work.
   y. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including prime contractor’s required corrective measures and actions.

4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.

5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. **Progress Meetings**: The Construction Manager will conduct progress meetings at weekly intervals. Coordinate dates of meetings with preparation of payment requests.

1. **Attendees**: In addition to representatives of Owner, Construction Manager, and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
   a. All Contractors are required to attend progress meetings, unless previously excused by Construction Manager. Contractors failing to be represented at project meetings, when specifically requested, will be taken into consideration when the A/E is considering payment applications for approval. A deduct Change Order for the unexcused meetings will be issued. This in no way relieves the Contractors for coordination due to lack of attendance. Punitive damage claims shall be in addition to fees charged.
   b. The representatives of the Contractor present shall have the authority to change the Contractor's work schedule or authorize work with the consent of the Construction Manager. If the Contractor fails to attend this meeting, it shall be his responsibility to obtain the information discussed at the meeting. Meeting notes
and the most current construction schedule will be in the office of the Construction Manager. Attendance at these meetings is required for Contractors’ payments.

1) Schedule Updating: Revise Contractor’s Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule monthly or as required by the Construction Manager.

2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
   a. Contractor’s Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor’s Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
      1) Review schedule for next period.
   b. Review present and future needs of each entity present, including the following:
      1) Interface requirements.
      2) Sequence of operations.
      3) Status of submittals.
      4) Deliveries.
      5) Off-site fabrication.
      6) Access.
      7) Site utilization.
      8) Temporary facilities and controls.
      9) Work hours.
      10) Hazards and risks.
      11) Progress cleaning.
      12) Quality and work standards.
      13) Status of correction of deficient items.
      14) Field observations.
      15) RFIs.
      16) Status of proposal requests.
      17) Pending changes.
      18) Status of Change Orders.
      19) Pending claims and disputes.
      20) Documentation of information for payment requests.

3. Minutes: The GC will record and distribute to CM and Architect the meeting minutes.

4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
   a. Schedule Updating: Revise Contractor’s Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule monthly or as required by the Construction Manger.

E. Coordination Meetings: Conduct Project coordination meetings at weekly intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and pre-installation conferences.

1. Attendees: In addition to representatives of Owner, Construction Manager, and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.

2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
   a. Combined Contractor’s Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to Combined Contractor’s Construction
Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

b. Schedule Updating: Revise Combined Contractor’s Construction Schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule monthly or as required by the Construction Manager.

c. Review present and future needs of each contractor present, including the following:
   1) Interface requirements.
   2) Sequence of operations.
   3) Status of submittals.
   4) Deliveries.
   5) Off-site fabrication.
   6) Access.
   7) Site utilization.
   8) Temporary facilities and controls.
   9) Work hours.
  10) Progress cleaning.
  11) Quality and work standards.
  12) Change Orders.

3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting, including but not limited to the Owner and all Prime Contractors.

F. Building Code Compliance Meeting: CM will schedule a Building Code Compliance with Authorities with Jurisdiction, at a time convenient to Owner, CM, and A/E, after execution of the Agreement and before beginning any on-site construction activities. Hold conference at Project Site or another convenient location. Conduct the meeting to review inspection responsibilities and personnel assignments.

1. Attendees: Authorized representatives of Owner, CM, A/E, and their consultants; Contractor and its superintendent; major subcontractors; testing agency; and other concerned parties shall attend the conference. All participants at conference shall be familiar with project testing and inspection requirements.

2. Agenda: Discuss items of significance that could affect progress, including the following:
   a. Introductions
      1) Business cards
   b. Purpose
      1) Coordinate inspection process
      2) Discuss special inspection process
      3) Prevent unnecessary delays
      4) Put names with faces
      5) Answer questions or concerns
   c. Status of Plan Approval
      1) Discuss submittal of outstanding plans
   d.
   f. Other phases of work that require State inspectors to conduct inspections
   g. Sequence of inspections, structural always last out
   h. Calling dispatch to obtain phone consultations from inspectors or supervisors
   i. Cancelling previously requested inspections
   j. Re-inspection fees if not ready or violations not corrected
   k. Changes required after plan approval
      1) Minor changes do not require plan review – discretion of Inspector
      2) Supervisors are notified if inspectors require plan approval of changes
      3) Best to submit electronically – notify Building Official to expedite review
   l. Temporary occupancy versus partial occupancy
1) Temporary occupancy is when entire building is to be occupied before other minor work is complete.
2) Temporary occupancy limited to 180 days unless approved by the Building Official.
3) Partial occupancy is for occupying portions of the building, while work is conducted in other areas.
4) Partial occupancy does not have a time limit.

m. Local Fire Official/State Fire Marshal inspections
n. Conflicts to be brought to the attention of the Building Official.

1.7 PRE-CLOSEOUT MEETING

A. When the work or designated portion thereof is 75 percent substantially complete, by billing, the Construction Manager and A/E will conduct a Pre-Closeout Meeting.

B. Minimum agenda will be to review Division 01 Section “Closeout Procedures”.
   1. O & M Manuals: Required at 75 percent completion.
   2. Prerequisites to Substantial Completion.
   3. Punch lists.
   4. Record Documents.
   5. Extra stock.
   6. Demonstration and training.
   7. Final Payment Application.

1.8 REQUESTS FOR INTERPRETATION (RFIs)

A. Procedure: Immediately on discovery of the need for interpretation of the Contract Documents, and if not possible to request interpretation at Project meeting, prepare and submit an RFI in the form specified.
   1. RFIs shall originate with Contractor. RFIs submitted by entities other than Contractor will be returned with no response.
   2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing interpretation and why a response is needed along with the following:
   1. Project name.
   2. Date.
   3. Name of Contractor.
   5. RFI number, numbered sequentially.
   6. Specification Section number and title and related paragraphs, as appropriate.
   7. Drawing number and detail references, as appropriate.
   8. Field dimensions and conditions, as appropriate.
   9. Contractor's suggested solution(s). Contractor shall set forth an interpretation or understanding of the requirement along with reasons why such an understanding was reached. If Contractor's solution(s) impact the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
   10. Contractor's signature.
   11. Attachments: Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing interpretation.
       a. Supplementary drawings prepared by Contractor shall include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments.
   12. Identify each page of attachments with the RFI number and sequential page number.
C. Software-Generated RFIs: Software-generated form with substantially the same content as indicated above.
   1. Attachments shall be electronic files in Adobe Acrobat PDF format.

D. Architect's and Construction Manager's Action: Architect and Construction Manager will review each RFI and determine action required. If it is determined that the document is not RFI, it will be returned to the Contractor, unreviewed as to content, for resubmittal on the proper form and in the proper manner. If the RFI is determined unnecessary or frivolous, by nature of the information clearly indicated in documents, the RFI will also be returned with no response. Numerous frivolous RFI that led to additional compensation to the design team shall result in change orders to the submitting contractor's contract. Allow 3 working days for Architect's response for each RFI. RFIs received after 1:00 p.m. will be considered as received the following working day. If a longer time is determined necessary, the Construction Manager or A/E will, within five working days of receipt of the request, notify the contractor of the anticipated response time. If the Contractor submits a RFI on an activity with 3 working days or more of float on the current Project schedule, Contractor shall not be entitled to any time extension due to the time it takes to respond provided the response is within either the initial 3 days or 3 days plus schedule "float time".
   1. The following RFIs will be returned without action:
      a. Requests for approval of submittals.
      b. Requests for approval of substitutions.
      c. Requests for coordination information already indicated in the Contract Documents.
      d. Requests for adjustments in the Contract Time or the Contract Sum.
      e. Requests for interpretation of Architect's actions on submittals.
      f. Incomplete RFIs or RFIs with numerous errors.
   2. Architect's action may include a request for additional information, in which case Architect's time for response will start again.
   3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Division 01 Section "Contract Modification Procedures."
      a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect and Construction Manager in writing within 10 days of receipt of the RFI response. Failure to give such written notice within 10 days shall waive the contractor's right to seek additional time or cost under the Changes article of the General Conditions.

E. On receipt of Architect's and Construction Manager's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect and Construction Manager within seven days if Contractor disagrees with response.

F. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Include the following:
   1. Project name.
   2. Name and address of Contractor.
   3. Name and address of Architect and Construction Manager.
   4. RFI number including RFIs that were dropped and not submitted.
   5. RFI description.
   6. Date the RFI was submitted.
   7. Date Architect's and Construction Manager's response was received.
   8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100
Undersigned certify by their respective signatures following:

We certify that we have reviewed all input and information necessary to coordinate installations required under our respective trades. We further certify that we have thoroughly reviewed coordination drawings and work of each other’s trades and we accept and agree that the Work indicated therein and required under Contract does not present conflicts, obstructions or installation problems between each trade that can not be resolved among ourselves during construction. We accept and agree that by signing this certification each of us is accepting responsibility for resolution of all installation conflicts, obstructions or problems associated with our individual trade created as a result of either not providing adequate input into preparation of coordination drawings, or their subsequent review, or lack of coordinating with the work of each other’s trades during installation, or simply disregarding installation requirements as indicated on coordination and Contract drawings, or as required by manufacturers of equipment and systems we are installing. Finally, we agree that Owner shall not be responsible for costs associated with resolution of installation problems resulting from inadequate or improper coordination between our trades.

General:

Contractor’s name

Contractor’s representative

Date

HVAC:

Contractor’s name

Contractor’s representative

Date

Electrical:

Contractor’s name

Contractor’s representative

Date

Plumbing:

Contractor’s name

Contractor’s representative

Date
REQUEST FOR INTERPRETATION

Project: ____________________________  R.F.I. Number: ____________________________
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>To: ________________</td>
<td>Date: ________________</td>
</tr>
<tr>
<td></td>
<td>A/E Project Number: ________________</td>
</tr>
<tr>
<td>Re: ________________</td>
<td>Contract For: ________________</td>
</tr>
</tbody>
</table>

Specification Section: ________________  Paragraph: ________________  Drawing Reference: ________________  Detail: ________________

Request:

Signed by: ____________________________  Date: ____________________________

Response:

☐ No response required. Request is not an RFI. Item is clearly indicated ________________  (Drawing/Specification)

☐ Attachments

Response From: ____________________________  To: ____________________________
|                                    |                                    |
| Date Rec’d: ________________          | Date Ret’d: ________________        |

Signed by: ____________________________  Date: ____________________________
PART 1 - GENERAL

1.01 WORK INCLUDED

A. The milestone schedule represents critical dates that must be met in order to finish by the final project completion date. The contractor shall plan for the necessary resources to achieve these dates. Upon notice to proceed, the overall project CPM schedule will be prepared in accordance with construction schedules. This CPM schedule will list the sequencing and duration of each specific work activity.

B. The submissions of shop drawings, product data and samples is critical to the timely completion of the various phases of the project, and as such, each contractor is responsible to make the required submissions as necessary to allow for reasonable review time and obtain the materials required to complete the work by the specified completion dates. All contractors shall comply with the following submittal requirements.

Submission deadlines for shop drawings are based on their relative impact on the construction schedule. The following represents the category distribution for shop drawings corresponding to the milestone construction schedule below.

C. In the event that a milestone is not met, responsible contractor’s retainage on their applications for payment may be increased until the milestone is satisfactorily met.

1.02 SCHEDULE OF MILESTONES

<table>
<thead>
<tr>
<th>Activity:</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notice to Proceed</td>
<td>October 10, 2017</td>
</tr>
<tr>
<td>Mobilize &amp; Begin Work Onsite</td>
<td>October 23, 2017</td>
</tr>
<tr>
<td>Temporary/Permanent Enclosure</td>
<td>April 20th, 2018</td>
</tr>
<tr>
<td>Start-up HVAC Equipment</td>
<td>May 18th, 2018</td>
</tr>
<tr>
<td>Ready for Punchlist</td>
<td>August 3rd, 2018</td>
</tr>
<tr>
<td>Occupancy Permit</td>
<td>August 17th, 2018</td>
</tr>
<tr>
<td>Project Complete</td>
<td>August 24th, 2018</td>
</tr>
</tbody>
</table>
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Administrative and procedural requirements for submittals required for performance of the Work, including the following:
   1. Action submittals
      a. Shop drawings
      b. Samples for Initial Selection
   2. Informational/Quality Assurance/Control Submittals
      a. Product data
      b. Samples for verification
      c. Qualification data
      d. Certifications
      e. Test reports
      f. Maintenance data
      g. Design data
      h. Manufacturer's instructions
      i. Manufacturer's field reports
      j. Coordination drawings
      k. LEED requirements

B. Related Sections include the following:
   1. Division 01 Section "Payment Procedures" for submitting Applications for Payment and the Schedule of Values.
   2. Division 01 Section "Project Management and Coordination" for submitting and distributing meeting and conference minutes and for submitting Coordination Drawings.
   3. Division 01 Section "Construction Progress Documentation" for submitting schedules and reports, including Contractor's Construction Schedule and the Submittals Schedule.
   4. Division 01 Section "Quality Requirements" for submitting test and inspection reports and for mockup requirements.
   5. Division 01 Section "Closeout Procedures" for submitting warranties.
   6. Division 01 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
   7. Division 01 Section "Operation and Maintenance Data" for submitting operation and maintenance manuals.
   8. Division 01 Section "Demonstration and Training" for submitting videotapes of demonstration of equipment and training of Owner's personnel.
   9. Divisions 02 through 50 Sections for specific requirements for submittals in those Sections.

1.3 DEFINITIONS

A. Action Submittals: Written and graphic information that requires A/E’s and Construction Manager’s responsive action.

B. Informational/Quality Assurance/Control Submittals: Written information that does not require A/E’s and Construction Manager’s approval. Submittals may be rejected for not complying with requirements.

1.4 SUBMITTAL PROCEDURE

A. General: Refer to Article 14 – Shop Drawings and Samples of the General Conditions.
B. Submittals, including those specified herein to be submitted to the A/E, excluding those directed to a specific individual, shall be submitted directly to the AE for review copying the CM through the share site provided by the CM.

C. Contractors on this Project shall provide submittals in accordance with the requirements of this Section. Where a submittal is required by a Contractor but assistance needed from others, Contractors shall participate and cooperate to expedite each submittal. Coordinate preparation and processing of submittals with performance of construction activities.
   1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
   2. Coordinate transmittal of different types of submittals for related parts of the work so processing will not be delayed because of need to review submittals concurrently for coordination.
      a. A/E reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

D. Where submission of samples, shop drawings, or other items are required from suppliers or subcontractors, it shall be the responsibility of the Contractor for whom the subcontractor is executing the Work to see that the submittal items required are complete and properly submitted, and corrected and resubmitted at the time and in the order required so as not to delay the progress of the Work. Submittals shall be made through the Contractor. Submittals shall include sufficient detail to determine that the contractor clearly understands the requirements of the Contract Documents.
   1. Submittal Schedule: Comply with requirements of Division 01 Section “Construction Progress Documentation” for list of submittals and time requirements for scheduled performance of related construction activities.
   2. Incomplete Submittals: By sending incomplete submittals, the contractor risks delaying completion of submittal review by submitting information that the A/E is likely to reject.

E. The Contractor shall check shop drawings, samples, and other submittals and submit them to the Construction Manager with a letter of transmittal giving his approval, comments, and suggestions.
   1. Each transmittal shall include the following information:
      a. Date submitted.
      b. Project title and number.
      c. Contractor's name and address.
      d. Identification by Specification Section, drawing number and detail references, as appropriate, and quantity submitted for each submittal.
      e. Name and address of subcontractor, manufacturer, and supplier.
      f. Notification of deviations from the Contract Documents for each submittal.

F. The Contractor shall prepare, review, and stamp with his approval and submit, with reasonable promptness or within the specified time periods and in orderly sequence so as to cause no delay in the Work or in the Work of another Contractor, submittals required by these Contract Documents or subsequently required by modifications.

G. The A/E shall review and take action on submittals with reasonable promptness, so as to cause no delay in the progress. Incomplete submittals may be returned without review with a request to resubmit when complete. Similarly, submittals containing non-specified items may be rejected. A reasonable period of time in accordance with approved project schedule for review of and action taken on submittals shall be as specified herein, but in no case shall it be less than 10 calendar days from the time it is received by the A/E until the time the submittal is marked and forwarded or returned. Contractor shall allow enough time for submittal review, including time for resubmittals, as follows:
   1. Initial Review: Allow 10 calendar days for initial review of each submittal, unless otherwise noted. Allow additional time if processing must be delayed to permit coordination with subsequent submittals or where concurrent review is required. A/E or Construction Manager will advise Contractor when a submittal being processed must be delayed for coordination.

013300-2 SUBMITTAL PROCEDURES
2. Concurrent Review: Where concurrent review of submittals by A/E’s team, consultants, Owner, other parties is required, allow 15 calendar days for initial review of each submittal.
3. Allow 10 calendar days for processing each resubmittal.
4. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing.

H. Submittals Not Required: A/E will send a transmittal indicating submittals were “not required for review”.

PART 2 - PRODUCTS

2.1 ACTION SUBMITTALS

A. General: Prepare and submit Action Submittals required by individual specification sections.

B. Shop Drawings: Prepare project specific information, drawn accurately to scale. Do not base shop drawings on reproductions of the Contract Documents or standard printed data.
1. The Contractor shall perform no portion of the Work requiring submittal and review of shop drawings, product data, samples or similar submittals until the A/E has approved the respective submittal. Such Work shall be in accordance with approved submittals.
2. Submit newly prepared information drawn accurately to scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the bases of Shop Drawings. Standard information prepared without specific reference to the Project is not a Shop Drawing.
3. Shop drawings are drawings, diagrams, illustrations, schedules, performance charts, brochures, and other data that are prepared by the Contractor or subcontractor, manufacturer, supplier, or distributor to illustrate some portion of the Work. Do not base shop drawings on reproduction of the Contract Documents.
   a. Advertising brochures will not be accepted as shop drawings.
   b. Erection and setting drawings as referred to in these Specifications will be considered as shop drawings and shall be submitted along with detailed shop drawings.
   c. Where schedules are required to indicate locations, they shall be submitted as part of the shop drawings package for that item.
   d. Shop drawings and schedules shall repeat the identification shown on the Contract Drawings.
   e. The Contractor shall check all shop drawings, samples and other submittals and submit them to the A/E utilizing a Transmittal Form, giving his approval and/or comments and suggestions. Failure to use a Transmittal Form will result in submittals being returned “without action”.
   f. Include the following information:
      1) Dimensions
      2) Identification of products and materials included by sheet and detail number
      3) Compliance with specified standards
      4) Notation of coordination requirements
      5) Notation of dimensions established by field measurements
      6) Fabrication and installation drawings
      7) Roughing-in and setting diagrams
      8) Wiring diagrams showing field installed wiring, including power, signal, and control wiring
      9) Shop work manufacturing instructions
     10) Templates and patterns
     11) Schedules
     12) Design calculations

4. Preparation of Submittals: Provide permanent marking on each submittal to identify project, date, Contractor, Subcontractor, submittal name, and similar information to distinguish it from other submittals. Show Contractor’s executed review and approval marking and provide space for A/E’s “action” marking. Package each submittal appropriately for transmittal and handling.
5. By approving and submitting shop drawings, the Contractor thereby represents that he has determined and verified field measurements, field construction criteria, materials, catalog numbers, and similar data, and that he has checked and coordinated each shop drawing with the requirements of the Work and of the Contract Documents prior to submitting to the A/E.

6. The Contractor shall make corrections required by the A/E and shall resubmit until appropriately marked. The Contractor shall direct specific attention in writing or on resubmitted shop drawings to revisions other than the corrections requested by the Architect on previous submissions.

7. The Architect will review shop drawings only for conformance with the design concept of the Project and with the information given in the Contract Documents. The Architect's review of a separate item shall not indicate review of an assembly in which the item functions.
   a. Only shop drawings, product data, and samples marked “No Exceptions Taken” or “Note Markings” shall be considered “final” and used in conjunction with the work of this Project.

8. The Architect’s review of shop drawings shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents unless the Contractor has informed the Architect in writing of such deviation at the time of submission and the Architect has given written approval to the specific deviation, nor shall the Architect’s action relieve the Contractor from responsibility for errors or omissions in the shop drawings.
   a. The Architect’s review of such submittals is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and qualities, or for substantiating instructions or performance of equipment or systems, all of which remain the responsibility of the Contractor as required by the Contract Documents. The Architect’s review shall not constitute approval of safety precautions or, unless otherwise specifically stated by the Architect, of any construction means, methods, techniques, sequences, or procedures. The Architect’s approval of a specific item shall not indicate approval of an assembly of which it is a component.

9. Notations and remarks added to shop drawings by the Architect are to ensure compliance to Drawings and Specifications and do not imply a requested or approved change to contract cost.

10. Should deviations, discrepancies, or conflicts between shop and contract drawings and Specifications be discovered, either prior to or after review, Contract Documents shall control and be followed.

11. Shop drawings and product data submittals shall be submitted electronically (not scanned). Samples and color charts must be submitted hard copy.

12. Shop drawings not requested by the Architect/Engineer shall be returned without action.

13. Shop drawings will be marked as follows: Contractor shall take the following action for each respective marking:
   a. "NO EXCEPTIONS TAKEN" - Copies will be distributed as indicated under above schedule.
   b. “NOTE MARKINGS/CONFIRM” – Final Release; Contractor may proceed with fabrication, taking into account the necessary corrections on submittal and with Contract Documents.
      1) Where the confirm box is checked, Contractor shall submit a letter, on company letterhead, stating Contractor shall perform work in accordance with markings. In lieu of letter, Contractor may resubmit corrected shop drawings.
   c. "NOTE MARKINGS/RESUBMIT" - Contractor may proceed with fabrication, taking into account the necessary corrections. Corrected shop drawings shall be resubmitted before fabrication of this work is complete to obtain a different action marking. Do not allow drawings marked "Resubmit" to be used in connection with installation of the Work.
   d. "REJECTED" - Contractor will be required to resubmit shop drawings in their entirety. No fabrication or installation shall be started until shop drawings so marked have been completely revised, resubmitted, and marked by Architect according to preceding Paragraphs a. or b.
C. Samples for Initial Selection: Prepare physical units of materials or products, including the following:
   1. The Contractor shall submit to the A/E samples to illustrate materials or workmanship, colors, and textures, and establish standards by which the Work will be judged.
   2. Samples for Initial Selection: Submit manufacturer’s color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
      a. Number of Samples for Initial Selection: Submit two full sets of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer’s product line. A/E will return one submittal with options selected.

2.2 INFORMATIONAL/QUALITY ASSURANCE/CONTROL SUBMITTALS

A. General: Prepare and submit informational submittals required by other Specification Sections.
   1. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. An officer shall sign certificates and certifications or other individual authorized to sign documents on behalf of that entity.
   2. Test and Inspection Reports: Comply with requirements in Division 01 Section “Quality Requirements”.

B. Product Data: Collect information into a single submittal for each element of construction or system. Product data includes printed information, such as manufacturer’s installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves.
   1. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products that are not required, mark copies to indicate the applicable information. Include the following information, as applicable:
      a. Manufacturer’s printed recommendations
      b. Manufacturer’s product specifications
      c. Manufacturer’s installation instructions
      d. Standard color charts
      e. Manufacturer’s catalog cuts
      f. Wiring diagrams showing factory installed wiring
      g. Operational range diagrams
      h. Standard product operating and maintenance manuals
      i. Compliance with trade association standards.
      j. Compliance with recognized testing agency standards.
      k. Application of testing agency labels and seals.
      l. Notation of dimensions verified by field measurement.
      m. Notation of coordination requirements.
   2. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.
      a. Preliminary Submittal: Submit a preliminary single copy of Product Data where selection of options is required.
   3. In compliance with the OSHA Hazard Communication Standard (1910.1200, 08-24-1987) Contractors shall post at the site MSDS (Material Safety Data Sheets) for ALL products classified as hazardous that their firm has knowledge that they will be furnishing, using, or storing on the jobsite during the duration of this Project in accordance with OSHA standards. At the completion of the project, the Contractor shall turn their "MSDS" information directly over to the Owner with a receipt for the Owner to sign. A copy of the signed receipt only shall be submitted to the Architect.
      a. Material Safety Data Sheets (MSDS) shall not be submitted to the Architect for review. Material Safety Data Sheets submitted to Architect will be returned with no action taken.

C. Samples for Verification: Submit full size, fully fabricated samples cured and finished as specified and physically identical with the material or product proposed. Samples include partial sections of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches showing color, texture, and pattern.
   1. Number of Samples for Verification: Submit 3 sets of samples. A/E will retain 1 sample set, unless otherwise noted.
2. Disposition: Maintain sets of approved samples at project site, available for quality control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
   a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such samples must be in an undamaged condition at time of use.
   b. Samples not incorporated into the Work, or otherwise designated as Owner’s property, are the property of Contractor.
3. Mount or display samples in the manner to facilitate review of qualities indicated. Prepare samples to match the Architect’s sample. Include the following:
   a. Specification Section number and reference.
   b. Generic description of the sample.
   c. Sample source.
   d. Product name or name of the manufacturer.
   e. Compliance with recognized standards.
   f. Availability and delivery time.
4. Submit samples for review of size, kind, color, pattern, and texture. Submit samples for a final check of these characteristics with other elements and a comparison of these characteristics between the final submittal and the actual component as delivered and installed.
   a. Where variation in color, pattern, texture, and other characteristic is inherent in the material or product represented, submit at least 3 multiple units that show approximate limits of the variations.
   b. Refer to other Specification Sections for requirements for samples that illustrate workmanship, fabrication techniques, and details of assembly, connections, operation, and similar construction characteristics.
5. By approving and submitting samples, the Contractor thereby represents that he has determined and verified materials, catalog numbers, and similar data, and that he has checked and coordinated each sample with the requirements of the Work and of the Contract Documents prior to submitting to the Architect.
6. The Contractor shall resubmit the required number of correct or new samples until approved. The Contractor shall direct specific attention in writing or on resubmitted samples to revisions other than the changes requested by the Architect on previous submissions.
7. The Architect will review samples but only for conformance with the design concept of the Project and with the information given in the Contract Documents. The Architect’s review of a separate item shall not indicate approval of an assembly in which the item functions.
8. The Architect’s action shall not relieve the Contractor of responsibility for deviations from the requirements of the Contract Documents unless the Contractor has informed the Architect in writing of the deviation at the time of submission and the Architect has given written approval to the specific deviation, nor shall the Architect’s action relieve the Contractor from responsibility for errors or omissions in the samples.
9. Unless otherwise specified, samples shall be in triplicate and of adequate size to show function, equality, type, color, range, finish, and texture of material. When requested full technical information and certified test data shall be supplied.
   a. Each sample shall be labeled, bearing material name and quality, the Contractor’s name, date, project name, and other pertinent data.
   b. Transportation charges to and from the Architect’s office must be prepaid on samples forwarded. The A/E shall retain samples until the Work for which they were submitted has been accepted.
10. Materials shall not be ordered until final review is received in writing from the A/E. Materials shall be furnished, equal in every respect to reviewed samples. Where color or shade cannot be guaranteed, the manufacturer shall indicate the maximum deviation. Work shall be in accordance with the final reviewed samples.

D. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of Architects and Owners, and other information specified.

E. Product Certificates: Prepare written statements on manufacturer’s letterhead certifying that product complies with requirements.
F. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.

G. Installer Certificates: Prepare written statements on manufacturer’s letterhead certifying that Installer complies with requirements and, where required, is authorized for this specific project.

H. Manufacturer Certificates: Prepare written statements on manufacturer’s letterhead certifying that manufacturer complies with requirements. Include evidence of manufacturing experience where required.

I. Material/Product Certificates: Prepare written statements on manufacturer’s letterhead certifying that material complies with requirements.

J. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency’s standard form, indicating and interpreting test results of material for compliance with requirements.

K. Preconstruction Test Reports: Prepare reports written by a qualified testing agency, on testing agency’s standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements.

L. Compatibility Test Reports: Prepare reports written by a qualified testing agency, on testing agency’s standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

M. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency’s standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements.

N. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
   1. Test reports shall be no older than 15 months, unless otherwise noted or approved by A/E.

O. Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements in Division 01 Section “Closeout Procedures”.

P. Design Data: Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumption and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

Q. Manufacturer’s Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:
   1. Preparation of substrates
   2. Required substrate tolerances
   3. Sequence of installation or erection
   4. Required installation tolerances
   5. Required adjustments
   6. Recommendations for cleaning and protection
R. Manufacturer’s Field Reports: Prepare written information documenting factory authorized service representative’s tests and inspections. Include the following, as applicable:
1. Name, address, and telephone number of factory authorized service representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

S. Material Safety Data Sheets (MSDSs): Submit information directly to Owner; do not submit to Architect.
1. Architect will not review submittals that include MSDSs and will return the entire submittal for resubmittal.

T. Coordination Drawings: Comply with requirements specified in Division 1 Section “Project Management and Coordination”.

U. LEED requirements for submittals will include all documentation, submitted by all contractors, required by the Architect for a successful certification of the project. The submittals containing LEED information shall be submitted separately and identified as such.

PART 3 - EXECUTION

3.1 CONTRACTOR’S REVIEW

A. Review each submittal and check for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Construction Manager.

B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor’s approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT’S AND CONSTRUCTION MANAGER’S ACTION

A. General: A/E will not review submittals that do not bear Contractor’s approval stamp and will return them without action.

B. Action Submittals: A/E will review each submittal, make marks to indicate corrections or modifications required, and return it.

C. Informational/Quality Assurance/Control Submittals: A/E will review each submittal and will not return it, or will reject and return it if it does not comply with requirements. A/E and Construction Manager will forward each submittal to appropriate party.

D. Partial submittals are not acceptable, will be considered non-responsive, and will be returned without review.

E. Submittals not required by the Contract Documents will not be reviewed and may be discarded.

END OF SECTION 013300
SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
   1. It is the intent of the Specifications and Drawings to accomplish a complete and first-grade installation executed by competent and experienced workmen.
   2. Equipment, specialties, and similar items shall be checked for compliance and approved prior to installation. Contractors are cautioned that work or equipment installed without approval is subject to condemnation, removal, and subsequent replacement with an approved item without extra remuneration.

B. Related Sections include the following:
   1. Division 01 Section "Allowances" for products selected under an allowance.
   2. Division 01 Section "Alternates" for products selected under an alternate.
   3. Division 01 Section "References" for applicable industry standards for products specified.
   4. Division 01 Section "Closeout Procedures" for submitting warranties for Contract closeout.
   5. Divisions 02 through 49 Sections for specific requirements for warranties on products and installations specified to be warranted.

1.3 DEFINITIONS

A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
   1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
   2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
   3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

1.4 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.
   1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
   2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect will determine which products shall be used.
1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.

B. Delivery and Handling:
1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.

C. Storage:
1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Store cementitious products and materials on elevated platforms.
5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.
8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

D. Each Contractor shall be responsible for materials he orders for delivery to the jobsite. Responsibility includes, but is not limited to, receiving, unloading, storing, protecting, and setting in place; ready for final connections.
1. The Owner will not be responsible for deliveries related to the construction or operation of the Contractor. The Owner cannot sign delivery forms for the Contractor.

E. Contractors shall insure that products are delivered to the Project in accordance with the Construction Schedule of the Project. In determining date of delivery, sufficient time shall be allowed for shop drawings and sample approvals, including the possibility of having to resubmit improperly prepared submittals or products other than those specified and the necessary fabrication or procurement time along with the delivery method and distance involved.

1.6 WARRANTIES

A. Specific warranties or bonds called for in the Contract Documents, in addition to that falling under the general warranty as set forth in General Conditions, shall be furnished in accordance with the requirements of the Specifications.
1. Owner's Recourse: Expressed warranties made to the Owner are in addition to implied warranties and shall not limit the duties, obligations, rights, and remedies otherwise available under law. Expressed warranty periods shall not be interpreted as limitations on the time in which the Owner can enforce such other duties, obligations, rights, or remedies.
   a. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
B. Each Contractor shall and does hereby agree to warrant for a period of one year, or for longer periods, where so provided in the Specifications, as evidenced by the date of Substantial Completion issued by the Architect (Certificate of Occupancy as long as the system/item is 100% complete), products installed under the Contract to be of good quality in every respect and to remain so for periods described herein.

C. Should defects develop in the aforesaid Work within the specified periods, due to faults in products or their workmanship, the Contractor hereby agrees to make repairs and do necessary Work to correct defective Work to the Architect's satisfaction, in accordance with the General and Supplementary Conditions. Such repairs and corrective Work, including costs of making good other Work damaged by or otherwise affected by making repairs or corrective Work, shall be done without cost to the Owner and at the entire cost and expense of the Contractor within 30 days after written notice to the Contractor by the Owner.

1. Related Damages and Losses: When correcting failed or damaged warranted construction, remove and replace construction that has been damaged as a result of such failure or must be removed and replaced to provide access for correction of warranted construction.

2. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

D. Nothing herein intends or implies that the warranty shall apply to Work that has been abused or neglected or improperly maintained by the Owner or his successor in interest.

E. Where service on products is required under this Article, it shall be promptly provided when notified by the Owner and no additional charge shall be made, unless it can be established that the defect or malfunctioning was caused by abuse or accidental damage not to be expected under conditions of ordinary wear and tear.

F. In the event movement in the adjoining structure or components causes malfunctioning, the Contractor responsible for the original installation of the adjoining structure or components shall provide such repair, replacement, or correction necessary to provide for proper functioning to bring the equipment back into the same operating condition as approved at the completion of the building.

G. The manufacturer and supplier expressly warrants that each item of equipment furnished by him and installed in this Project is suitable for the application shown and specified in the Contract Documents and includes features, accessories, and performing characteristics listed in the manufacturer's catalog in force on the date bids are requested for the Work. This warranty is intended as an assurance by the manufacturer that his equipment is not being misapplied and is fit and sufficient for the service intended. This warranty is in addition to and not in limitation of other warranties or remedies required by law or by the Contract Documents. It shall be the responsibility of the Contractor for the particular equipment to obtain this warranty in writing.

H. In case the Contractor fails to do Work so ordered, the Owner may have Work done and charge the cost thereof against monies retained as provided for in the Agreement and, if said retained monies shall be insufficient to pay such cost or if no money is available, the Contractor and his Sureties shall agree to pay to the Owner the cost of such Work.

I. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.

2. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.
J. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
   1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
   2. Specified Form: When specified forms are included with the Specifications, prepare a written document using appropriate form properly executed.
   3. Refer to technical specification sections for specific content requirements and particular requirements for submitting special warranties.

K. Submittal Time: Comply with requirements in Division 01 Section "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.
   1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
   2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
   3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
   4. Where products are accompanied by the term "as selected," Architect will make selection.
   5. Where products are accompanied by the term "match sample," sample to be matched is Architect's.

B. Product Selection Procedures:
   1. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements.
   2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.
   3. Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.
   4. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
   5. Product Options: Where Specifications indicate that sizes, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide the specified product or system. Comply with provisions in Part 2 "Product Substitutions" Article for consideration of an unnamed product or system.
      a. If no product available within specified category matches and complies with other specified requirements, comply with provisions in Part 2 "Product Substitutions" Article for proposal of product.
   7. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, and textures" or a similar phrase, select a product that complies with other specified requirements.
      a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that does not include premium items.

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b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 PROTECTION

A. Each Contractor shall protect building elements and products subject to damage. Should workmen or other persons employed or commissioned by a Contractor be responsible for damage, the entire cost of repairing said damage shall be assumed by that individual Contractor. Should damage be done by a person or persons not employed or commissioned by a Contractor, the respective Contractors shall make repairs and charge the cost to the guilty person or persons. The affected Contractors shall be responsible for collecting such charges. If the person or persons responsible for damage cannot be discovered, the respective Contractor shall make full and satisfactory repairs, and the cost of Work shall be prorated against each Contractor.

B. The respective Contractors shall protect their products prior to installation and final acceptance. Storage shall be dry, clean, and safe. Materials or equipment damaged, deteriorated, rusted, or defaced due to improper storage shall be repaired, refinished, or replaced, as required by the Architect. Products lost through theft or mishandling shall be replaced by the Contractor without cost to the Owner.

2.3 ACCEPTANCE OF EQUIPMENT OR SYSTEMS

A. The Owner will not accept the start of the warranty period on systems or equipment until Contract Completion is issued to the respective Contractor(s) for Owner's occupancy of the building, in part or whole. Each Contractor shall make such provisions as required to extend the manufacturer's warranty from time of initial operation of systems or equipment until Substantial Completion is given in writing.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:
   2. Field engineering and surveying.
      a. Anchor bolt location survey.
   4. Starting and adjusting.
   5. Protection of installed construction.
   6. Correction of the Work.

B. Related Sections include the following:
   1. Division 01 Section "Project Management and Coordination" for procedures for coordinating field engineering with other construction activities.
   2. Division 01 Section "Submittal Procedures" for submitting surveys.
   3. Division 01 Section "Cutting and Patching" for procedural requirements for cutting and patching necessary for the installation or performance of other components of the Work.
   4. Division 01 Section "Construction Cleaning" for progress cleaning.
   5. Division 01 Section "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

1.3 SUBMITTALS

A. Quality Assurance/Control Submittals:
   1. Qualification Data: For land surveyor or professional engineer.
   2. Certificates: Submit certificate signed by land surveyor or professional engineer certifying that location and elevation of improvements comply with requirements.
   3. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.
   4. Certified Surveys: Submit 3 copies signed by land surveyor or professional engineer.

B. Final Property Survey: Submit one hard copy and two electronic copies (CD & USB) showing the Work performed and record survey data.

1.4 QUALITY ASSURANCE

A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar to those indicated for this project in material, design, and extent.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
   1. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
      a. Description of the Work.
      b. List of detrimental conditions, including substrates.
      c. List of unacceptable installation tolerances.
      d. Recommended corrections.
   2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
   3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
   4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
   5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to Owner and Construction Manager that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.


3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect and Construction Manager promptly.
   1. Locate and protect existing benchmarks and control points. Preserve permanent reference points during construction. Do not change or relocate benchmarks or control points without prior written approval. Promptly report lost or destroyed reference points or requirements to relocate reference points because of necessary changes in grades or locations.
   2. Promptly replace lost or destroyed project control points. Base replacements on the original survey control points.

B. General: Engage a land surveyor or professional engineer to lay out the Work using accepted surveying practices.
1. Establish a minimum of 2 permanent benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
2. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
3. Inform installers of lines and levels to which they must comply.
4. Check the location, level and plumb, of every major element as the Work progresses.
5. Notify Architect and Construction Manager when deviations from required lines and levels exceed allowable tolerances.
6. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and invert elevations.

D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect and Construction Manager.

3.4 FIELD ENGINEERING

A. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect or Construction Manager. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect and Construction Manager before proceeding.
2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.

B. Benchmarks: Establish and maintain a minimum of 2 permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

C. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and site work.
1. Anchor Bolt Survey Location: On completion of anchor bolt installation and prior to erecting steel, prepare a certified survey showing dimensions, locations, angles, and elevation of anchor bolts.

D. Final Property Survey: Prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor or professional engineer, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
2. Recording: At Contract Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

3.5 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
   1. Make vertical work plumb and make horizontal work level.
   2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
   3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

G. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
   1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
   2. Allow for building movement, including thermal expansion and contraction.
   3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 STARTING AND ADJUSTING

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Manufacturer's Field Service: If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Division 01 Section "Quality Requirements."
3.7 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Contract Completion.

B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.8 CORRECTION OF THE WORK

A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Division 01 Section "Cutting and Patching."
   1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

B. Restore permanent facilities used during construction to their specified condition.

C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 017300
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes procedural requirements for cutting and patching.

B. Related Sections include the following:
   1. Divisions 02 through 50 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.
   2. Division 07 Section "Penetration Firestopping" for patching fire-rated construction.

1.3 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.

B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

C. Cutting and patching performed during the manufacture of products or during the initial fabrication, erection, or installation processes is not considered to be "cutting and patching" under this definition. Drilling of holes to install fasteners and similar operations are also not considered to be "cutting and patching".

1.4 SUBMITTALS

A. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
   1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
   2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building’s appearance and other significant visual elements.
   3. Products: List products to be used and firms or entities that will perform the Work.
   4. Dates: Indicate when cutting and patching will be performed.
   5. Utility Services and Mechanical/Electrical Systems: List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.
   6. Architect’s Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

1.5 QUALITY ASSURANCE

A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
   1. Obtain approval of the cutting and patching proposal before cutting and patching the following structural elements:
      a. Foundation construction.
      b. Bearing and retaining walls.
c. Structural concrete.

d. Structural steel.

e. Lintels.

f. Structural decking.

g. Miscellaneous structural metals.

h. Exterior curtainwall construction.

i. Equipment supports.

j. Piping, ductwork, vessels, and equipment.

B. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operating elements include the following:

1. Primary operational systems and equipment.

2. Air or smoke barriers.

3. Fire-suppression systems.

4. Mechanical systems piping and ducts.

5. Control systems.

6. Communication systems.

7. Conveying systems.

8. Electrical wiring systems.

C. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Miscellaneous elements include the following:

1. Water, moisture, or vapor barriers.

2. Membranes and flashings.

3. Equipment supports.

4. Piping, ductwork, vessels, and equipment.

5. Noise- and vibration-control elements and systems.

D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

B. In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.

1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers.

2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.
3.2 PREPARATION

A. Temporary Support: Provide temporary support of Work to be cut.

B. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

3.3 PERFORMANCE

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

2. Do not use cutting torches.

3. Each Contractor shall make arrangements for fitting his Work into the General Construction. Where the Contractor was given sufficient information as to require openings prior to construction and then the cost for cutting and restoring shall be paid for by the Contractor failing to provide the required openings.

4. Each Contractor shall be responsible for cutting, fitting, and patching that may be required to complete his Work. Contractors shall not endanger Work of other Contractors by cutting, excavating, or otherwise altering Work: and shall not cut or alter the Work of other Contractors except with written consent of the Architect. Costs caused by defective or ill-timed Work shall be borne by the party responsible.

5. Cutting or restoring performed by Contractors which is condemned by the Architect shall have such correction or restoration work performed through the General Contractor when so instructed by the Architect. The cost of such Work shall be borne by the Contractor responsible for the originally defective Work.

6. Cutting and patching of concrete floors and decks shall be performed in neat and workmanlike manner, using a coring machine. Contractor for such work must form openings over 6-inch diameter. After coring, each Contractor shall pack and grout openings around sleeves or Work penetrating the floor or deck which he is furnishing.

7. No Contractor shall do cutting that may impair the strength of the building or its components. No holes except for small screws or bolts may be drilled in the beams or other structural members for the purpose of supporting, routing, or attaching Work without obtaining prior approval from the Architect.

8. Each Contractor shall do his own cutting and patching work in the existing building. This shall include cutting and patching required to install new utilities on the site.

9. Refer to other Sections of these Specifications for specific cutting and patching requirements and limitations applicable to individual units of Work.

10. Unless otherwise specified, requirements of this Section apply to Mechanical and Electrical Work.

B. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.

2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.

3. Concrete or Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.

4. Excavating and Backfilling: Comply with requirements in applicable Division 31 Sections where required by cutting and patching operations.

5. Proceed with patching after construction operations requiring cutting are complete.
C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.
   1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
   2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
      a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
      b. Restore damaged pipe covering to its original condition.
   3. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weather tight condition.

D. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

END OF SECTION 017329
SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
   1. Inspection procedures.
      a. Prerequisites to Final Inspection and Acceptance.
   2. Final cleaning.
   3. Certification of code compliance.
   4. Punch list.

B. Related Sections include the following:
   1. Division 01 Section "Payment Procedures" for requirements for Applications for Payment for Substantial and Final Completion.
   2. Division 01 Section "Execution" for progress cleaning of Project site.
   3. Division 01 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
   4. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
   5. Division 01 Section "Demonstration and Training" for requirements for instructing Owner's personnel.
   6. Divisions 02 through 50 Sections for specific closeout and special cleaning requirements for the Work in those Sections.

1.3 PREREQUISITIES TO FINAL INSPECTION AND ACCEPTANCE

A. Preliminary Procedures: Before requesting inspection for determining date of Final Inspection and Acceptance, complete the following.
   1. Submit copy of itemized work to be completed or corrected, stating the value of items on the list, and reasons why Work is not complete.
      a. Punch list shall contain closeout documents not yet delivered to CM, Architect, or Owner.
   2. Submit final payment request, with releases and supporting documentation not previously submitted and accepted.
      a. Payment for items to be completed and corrected shall be retained at 200 percent of their value.
      b. Final Payment will not be released until all paperwork is completed and submitted.
      c. Retainage is not released until the Certification of Contract Completion is signed by all parties. Partial release of Retainage is not a typical procedure.
   3. Submit all record document submittals and similar final record information.
   4. Advise Owner of pending insurance change over requirements. Submit evidence of final continuing insurance coverage complying with insurance requirements.
   5. Submit specific warranties, workmanship/maintenance bonds, maintenance agreements, agreements, final certifications, and similar documents. Including but not limited to the following:
      a. Certificate occupancy operating certificates and similar releases.
      b. Inspection Certificates.
      c. Certification stating that no materials containing more than 1 percent asbestos was incorporated into the Work.
      d. Plumbing Contractor shall submit certification stating that no flux or solder used for drinking water piping contained more than 0.2 percent lead, and that no pipe or fittings used for drinking water piping contained more than 8.0 percent lead.
e. Certification that all fire stopping systems was installed in accordance with Contract Documents.

6. Deliver tools, spare parts, extra stocks of materials, and similar physical, items to Owner and obtain a receipt. Label with manufacturer's name and model number where applicable. All materials to be reported by unit quantifications and not by percentages.

7. Make final changeover of locks and transmit keys to Owner and advise Owner's personnel of changeover in security provisions.

8. Complete start-up testing of systems and instructions of Owner's operating/maintenance personnel. Discontinue and remove from project site temporary facilities and services, along with construction tools, mock-ups, and similar elements.


10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.

11. Submit final meter readings for utilities, a measured record of stored fuel, and similar data as of the date of “Contract Completion” or when the Owner took possession of and assumed responsibility for corresponding elements of the Work.

12. Complete final cleaning-up requirements.

13. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

B. Final Inspection: Contractor shall submit the “Contractor's Punch List” to the Construction Manager and the Architect, with a request for a Final Inspection of the Work. On receipt of request, Architect and Construction Manager will either proceed with inspection or notify Contractor of unfilled requirements.

1. The Construction Manager shall notify the Contractor, the Architect, and the School District Board of scheduled time of Final Inspection.

2. Architect’s Punch List will be combined with Contractor’s Punch List and issued to Contractor’s by Construction Manager.

1.4 PREREQUISITES TO CONTRACT COMPLETION

A. Contractor shall request a re-inspection by Architect and CM when all “Punch List Items” have been completed. Final inspection shall occur within 30 days of issuance of Architect’s Punch List.

1. Contractor shall indicate any items to be deferred in request.

B. Re-inspection: Architect and CM will re-inspect work and if items have been completed and record documents have been received, CM will process a Certificate of Contract Completion.

1.5 CERTIFICATION OF CODE COMPLIANCE

A. Prior to final payment the Contractors indicated below shall submit through the Construction Manager to the Architect (in duplicate) letters of certification of code compliance as follows:

1. The Contractors for Divisions 21, 22, and 23 Work shall submit letter certifying mechanical installations comply with the current applicable editions of the State and Local Codes having jurisdiction.

2. The Contractors for Divisions 26 and 28 Work shall submit letters certifying that the electrical wiring, alarm systems, smoke and heat detection systems comply with current applicable editions of the State and Local Codes having jurisdiction.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
   a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
   b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
   c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
   d. Remove tools, construction equipment, machinery, and surplus material from Project site.
   e. Remove snow and ice to provide safe access to building.
   f. Clean exposed exterior and interior hard-surface finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
   g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
   h. Sweep concrete floors broom clean in unoccupied spaces.
   i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
   j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
   k. Remove labels that are not permanent.
   l. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
      1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
   m. Replace parts subject to unusual operating conditions.
   n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
   o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
   p. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
   q. Leave Project clean and ready for occupancy.

C. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid Project of rodents, insects, and other pests. Prepare a report.
D. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner’s property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION 017700
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
   1. Operation and maintenance documentation directory.
   2. Emergency manuals.
   3. Operation manuals for systems, subsystems, and equipment.
   4. Maintenance manuals for the care and maintenance of products, materials, finishes, and systems and equipment.

B. Related Sections include the following:
   1. Division 01 Section "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
   2. Division 01 Section "Closeout Procedures" for submitting operation and maintenance manuals.
   3. Division 01 Section "Project Record Documents" for preparing Record Drawings for operation and maintenance manuals.
   4. Divisions 02 through 49 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 SUBMITTALS

A. General: At the time of Contractor's pay application reaches 75 percent complete, each Prime Contractor shall submit to the A/E, through the CM, one copy of a rough draft for a comprehensive Maintenance and Operating Manual presenting complete directions and recommendations for the proper care and maintenance of visible surfaces as well as maintenance and operating instructions for equipment items which he has provided.
   1. If the project is being constructed in Phases, provide Maintenance and Operating Manuals at the completion of each Phase of Work.

B. Final Submittal: Submit two electronic copies (CD & USB) along with two (2) hard copies in a white three ring binder with a cover sheet and binder spine in final form within 30 days of the date draft was reviewed. A/E will return copy with comments within 15 days or approve as submitted.
   1. Correct or modify each manual to comply with Architect's comments. Submit 3 copies of each corrected manual, to the CM, within 15 days of receipt of Architect's comments.

1.5 COORDINATION

A. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.
PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

A. Organization: Include a section in the directory for each of the following:
   1. List of documents.
   2. List of systems.
   3. List of equipment.
   4. Table of contents.

B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.

C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.

D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems." Items in electronic format must be "bookmarked" and a table of contents hyperlinked for ease of navigating through the electronic file. Hard copies to utilize dividers and tabs that correlate with the table of contents.

2.2 MANUALS, GENERAL

A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
   1. Title page.
   2. Table of contents.

B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:
   1. Subject matter included in manual.
   2. Name and address of Project.
   3. Name and address of Owner.
   4. Date of submittal.
   5. Name, address, and telephone number of Contractor.
   6. Name and address of Architect.
   7. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
   1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
   1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.

b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.

3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.


5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
   a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
   b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.3 EMERGENCY MANUALS

A. Content: Organize manual into a separate section for each of the following:
   1. Type of emergency.
   2. Emergency instructions.
   3. Emergency procedures.

B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
   1. Fire.
   2. Flood.
   5. Power failure.
   7. System, subsystem, or equipment failure.
   8. Chemical release or spill.

C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

D. Emergency Procedures: Include the following, as applicable:
   1. Instructions on stopping.
   2. Shutdown instructions for each type of emergency.
   3. Operating instructions for conditions outside normal operating limits.
   4. Required sequences for electric or electronic systems.
   5. Special operating instructions and procedures.

2.4 OPERATION MANUALS

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
   1. System, subsystem, and equipment descriptions.
   2. Performance and design criteria if Contractor is delegated design responsibility.
   3. Operating standards.
   4. Operating procedures.
   5. Operating logs.
   6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:
1. Product name and model number.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
1. Standard printed maintenance instructions and bulletins.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training videotape, if available.

E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
   1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
   2. Maintenance and Service Record: Include manufacturers’ forms for recording maintenance.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers’ maintenance documentation and local sources of maintenance materials and related services.

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
   1. Include procedures to follow and required notifications for warranty claims.
   2. Submit a binder, organized by CSI Divisions, with all Warrantees to the Owner, through the CM.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.

B. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner’s operating personnel for types of emergencies indicated.

C. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

D. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
   1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
   2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner’s operating personnel.

E. Manufacturers’ Data: Where manuals contain manufacturers’ standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
   1. Prepare supplementary text if manufacturers’ standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

F. Drawings: Prepare drawings supplementing manufacturers’ printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
   1. Do not use original Project Record Documents as part of operation and maintenance manuals.
2. Comply with requirements of newly prepared Record Drawings in Division 01 Section "Project Record Documents."

G. Warrantees required for O&M submission are separate copies from those also submitted in the separate Warrantee Binder.

END OF SECTION 017823
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for Project Record Documents.

B. Related Sections include the following:
   1. Division 01 Section "Closeout Procedures" for general closeout procedures.
   2. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
   3. Divisions 02 through 49 Sections for specific requirements for Project Record Documents of the Work in those Sections.

1.3 SUBMITTALS

A. Record Drawings: Comply with the following:
   1. Number of Copies: Submit marked-up Record Prints.

PART 2 - PRODUCTS

2.1 PROJECT RECORD DOCUMENTS

A. Record Documents, General
   1. The single prime/GC shall maintain at the jobsite one copy of Drawings, Project Manual, addenda, final shop drawings, change orders, field orders, other contract modifications, and other documents submitted by the Contractor, in compliance with various Sections of the Project Manual. These record drawings are to be kept electronically in a program similar to Bluebeam. These record drawings shall also include any as-built information. This electronic file is to be turned over to the architect via the CM during the closeout process.

B. Record Drawings
   1. Prime Contractor shall update "Record Drawings" on separate blue or black line prints set-aside especially for this purpose on the job. Drawings shall incorporate changes made in the Work of the respective trades during the construction period. Such changes shall be indicated at the time they occur.
      a. Accurately record information in an understandable drawing technique.
      b. Record data as soon as possible after obtaining it. Record and check markup prior to enclosing concealed installations.
   2. Each of these project record drawings shall be clearly marked "Drawings of Record"; maintained in good condition; available for observation by the Architect; and shall not be used for construction purposes. Mark these drawings to show the actual installation where the installation varies from the installation shown originally. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later. Items required to be marked include, but are not limited to, the following:
      a. Dimensional changes to the Drawings.
      b. Significant detail not shown in the original Contract Documents including Change Orders or Field Work Orders.
      c. The location of underground utilities and appurtenances dimensionally referenced to permanent surface improvements.
d. The location of internal utilities and appurtenances concealed in building structures, referenced to visible and accessible features of the structures.
e. When elements are placed exactly as shown on Drawings, so indicate otherwise show-changed location.
f. Revisions to details shown on the Drawings.
g. Depths of foundations below the first floor.
h. Revisions to routing of piping and conduits.
i. Revisions to electrical circuiting.
j. Actual equipment locations.
k. Duct size and routing.
l. Details not on original Contract Drawings.

3. Keep project record drawings current. Do not permanently conceal work until the required information has been recorded. Mark record prints of Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. Where shop drawings are marked, show cross-reference on Contract Drawings location.
   a. Mark record sets with red, or color that may be photocopied, erasable colored pencil. Use other colors (no blue) to distinguish between changes for different categories of the work at the same location.
   b. Note Field Work Orders, alternate numbers, change order numbers, and similar identification.

4. Prior to request for certificate of Contract Completion, each Prime Contractor shall organize the Record Drawings into manageable sets, bind the sets with durable paper cover sheets, certify to the accuracy of the Record Drawings by signature thereon, and deliver the Record Drawings to the Architect, through the Construction Manager.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project. Provide an electronic copy and one hard copy of these records sets.

B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Architect's and Construction Manager's reference during normal working hours.

END OF SECTION 017839
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
   1. Demonstration of operation of systems, subsystems, and equipment.
   2. Training in operation and maintenance of systems, subsystems, and equipment.
   3. Demonstration and training videotapes.
B. Related Sections include the following:
   1. Division 01 Section "Project Management and Coordination" for requirements for pre-instruction conferences.
   2. Divisions 02 through 49 Sections for specific requirements for demonstration and training for products in those Sections.

1.3 SUBMITTALS
A. Instruction Program: Submit 2 copies of outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
   1. At completion of training, submit one complete training manual(s) for Owner's use.
B. Qualification Data: For instructor.
C. Attendance Record: For each training module, submit list of participants and length of instruction time.
D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.
E. Demonstration and Training Videotape/DVD: Submit 2 copies (CD & USB) within 7 days of end of each training module.
   1. Identification: On each copy, provide an applied label with the following information:
      a. Name of Project.
      b. Name and address of photographer.
      c. Name of Architect and Construction Manager.
      d. Name of Contractor.
      e. Date videotape was recorded.
      f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
   2. Transcript: Prepared on 8-1/2-by-11-inch paper, punched and bound in heavy-duty, 3-ring, vinyl-covered binders. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding videotape. Include name of Project and date of videotape on each page.

1.4 QUALITY ASSURANCE
A. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Division 01 Section "Quality Requirements," experienced in operation and maintenance procedures and training.

1.5 COORDINATION
A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.
B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections.
   1. Training should occur for all MEP/T systems whether or not it’s called for in the technical specifications. Minimum of 4 hours person system/equipment should be assumed.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following:
   1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
      a. System, subsystem, and equipment descriptions.
      b. Performance and design criteria if Contractor is delegated design responsibility.
      c. Operating standards.
      d. Regulatory requirements.
      e. Equipment function.
      f. Operating characteristics.
      g. Limiting conditions.
      h. Performance curves.
   2. Documentation: Review the following items in detail:
      a. Emergency manuals.
      b. Operations manuals.
      c. Maintenance manuals.
      d. Project Record Documents.
      e. Identification systems.
      f. Warranties and bonds.
      g. Maintenance service agreements and similar continuing commitments.
   3. Emergencies: Include the following, as applicable:
      a. Instructions on meaning of warnings, trouble indications, and error messages.
      b. Instructions on stopping.
      c. Shutdown instructions for each type of emergency.
      d. Operating instructions for conditions outside of normal operating limits.
      e. Sequences for electric or electronic systems.
      f. Special operating instructions and procedures.
   4. Operations: Include the following, as applicable:
      a. Startup procedures.
      b. Equipment or system break-in procedures.
      c. Routine and normal operating instructions.
      d. Regulation and control procedures.
      e. Control sequences.
      f. Safety procedures.
      g. Instructions on stopping.
      h. Normal shutdown instructions.
      i. Operating procedures for emergencies.
      j. Operating procedures for system, subsystem, or equipment failure.
      k. Seasonal and weekend operating instructions.
      l. Required sequences for electric or electronic systems.
      m. Special operating instructions and procedures.
   5. Adjustments: Include the following:
      a. Alignments.
      b. Checking adjustments.
      c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:
   a. Diagnostic instructions.
   b. Test and inspection procedures.

7. Maintenance: Include the following:
   a. Inspection procedures.
   b. Types of cleaning agents to be used and methods of cleaning.
   c. List of cleaning agents and methods of cleaning detrimental to product.
   d. Procedures for routine cleaning
   e. Procedures for preventive maintenance.
   f. Procedures for routine maintenance.
   g. Instruction on use of special tools.

8. Repairs: Include the following:
   a. Diagnosis instructions.
   b. Repair instructions.
   c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   d. Instructions for identifying parts and components.
   e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION
   A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual.
   B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION
   A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
   B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
   C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.  
      1. Schedule training with Owner, through Construction Manager, with at least 14 days' advance notice.
   D. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a demonstration performance-based test.
   E. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

3.3 DEMONSTRATION AND TRAINING VIDEOTAPES
   A. General: Record each training module session separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.  
      1. At beginning of each training module, record each chart containing learning objective and lesson outline.
   B. Videotape/DVD Format: Provide high-quality color DVDs & USBs.

END OF SECTION 017900
SECTION 019500

SAFETY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Attention is directed to Bidding and Contract Requirements, and to Division 1, General Conditions and Special Conditions, which are hereby made a part of this Section.

1.02 SUMMARY

A. This Section describes the on-site project safety and loss control program requirements including:

1. Contractor's Contract Requirements for Safety
2. On-Site Safety and Loss Control Program Content
3. Project Safety Guide
4. Safety Related Forms

1.03 CONTRACTOR’S CONTRACT REQUIREMENTS FOR SAFETY

A. Each Contractor and Subcontractor is responsible for their own Safety Program in accordance with applicable provisions of the Occupational Safety and Health Act; and shall, in addition, adopt the Project Safety Program for work on this project. Every Contractor and Subcontractor shall comply with all applicable local, state and federal Safety and Health Regulations. In addition, each Contractor shall be responsible for payment of all fines and/or claims levied against the Owner, Architect or the Construction Manager for deficiencies relating to conduct of the Contractor’s work. The General Trades contractor will be responsible for overall site safety.

B. As a Contractor and employer, you are required by Federal and State Occupational Safety and Health Regulations, Standards, Codes, Rules and Regulations in addition to Contract Rules and Regulations to provide protection for our customer’s employees, the construction trades people and the public who could come into contact with your operations.

C. In addition to all state and federal safety laws and regulations, each contractor shall comply with the requirements of the Construction Managers “On-Site Project Safety and Loss Program”. In addition, each Contractor shall sign and return the Contractors Safety Performance Program Form, the Trade Contractor Safety Program Review Checklist. The Contractors Safety Performance Program Form and Trade Contractor Safety Program Review Checklist are located at the end of this section. These forms shall be completed prior to award of contract and used in the bid evaluation. All OSHA requirements will be adhered to.

D. The information contained within the Construction Manager On-Site Project Safety and Loss Control Program in no way relieves Contractors or Subcontractors or Suppliers of their lawful or contractual responsibilities and obligations for safety. Suppliers and/or Subcontractors should seek professional guidance (legal/safety) in developing their own safety rules and programs.

E. Each Contractor shall submit the following information to the Construction Manager Construction Manager before Bid Award:

1. An executed Contractor Safety Performance Program Form

2. An executed Trade Contractor Safety Program Review Checklist

3. The names of persons or entities proposed as first tier contractors.
F. Each Contractor shall submit to the Construction Manager the information listed in Item 2.02.B.3 before starting any work on the project.

G. The Contractor understands and agrees not to use or incorporate hazardous materials (as defined in Section 00840 - Hazardous Materials)

The Contractor shall provide to the Construction Manager, a copy of its Hazard Communications Program and Material Safety Data Sheets for all hazardous chemicals used in the performance of the Work. MSDS's shall be limited to only those materials used on the Project. Subcontractors shall be responsible to update the Haz-Com information provided to the Construction Manager as additional hazardous chemicals/materials are delivered to the project site.

PART 2 - ON-SITE PROJECT SAFETY AND LOSS CONTROL PROGRAM CONTENT

2.01 INTRODUCTION

A. The Construction Manager recognizes that it is important to our successful operation to prevent the occurrence of incidents that lead to occupational injuries or illnesses. We must all be committed to the performance of our duties in a safe manner, consistent with good construction practices.

B. Accidents occur because of unsafe acts by people or unsafe conditions within the work area. The objective of this Safety and Loss Control Program is to eliminate and/or control these two basic accident causes.

C. The Construction Manager demands that OSHA regulations and the Construction Managers "On-site Project Safety and Loss Control Program" be observed and maintained in all cases.

D. The Construction Manager seeks your cooperation in providing a safe place to work for all employees. We believe that safety is a fundamental part of our jobs and a fundamental part of an efficient and profitable production. Prevention of accidents is positive thinking.

2.02 RESPONSIBILITIES

A. GENERAL RESPONSIBILITIES

1. All work shall be conducted in a safe and practical manner in conformance with the Occupational Safety and Health Act of 1970, OSHA Safety and Health Regulations. And,

2. The Project Safety Guide (the last three pages of this program) shall be posted in a conspicuous location along with emergency phone numbers, OSHA and EEO posters.

B. CONTRACTORS

1. Prior to award of contract:

   c. Resume of proposed Field Superintendent and Site Safety Representative.

2. Each Contractor and Sub-contractor will be responsible for the safety and loss control of employees and area of work under their control.

3. Each Contractor shall submit the following information to the Construction Manager for approval prior to commencement of the work: (also refer to the Contractor Safety Program Checklist for basic requirements)
a. The Contractor's written, specific Site Safety Program applying the contractor’s safety policy, responsibilities and procedures.

b. The Contractor's written Hazard Communication Program.

c. Contractor's written substance abuse policy/program.

4. The Contractor will maintain and upon request provide to the Construction Manager written records of the following as stipulated:

<table>
<thead>
<tr>
<th>Document</th>
<th>Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment Safety Inspection Report (for 8 ton and larger lift cranes)</td>
<td>Before Use of Equipment</td>
</tr>
<tr>
<td>Respirator Procedures</td>
<td>Before Start of this Work</td>
</tr>
<tr>
<td>Confined Space Procedures</td>
<td>Before Start of this Work</td>
</tr>
<tr>
<td>Accident Reports</td>
<td>Within 24 hours of occurrence</td>
</tr>
<tr>
<td>Tool Box Safety meetings/self inspections</td>
<td>Weekly</td>
</tr>
<tr>
<td>Contractor Safety Statistics</td>
<td>Monthly</td>
</tr>
<tr>
<td>Annual Crane Inspections</td>
<td></td>
</tr>
</tbody>
</table>

5. Each Contractor may be requested to provide the Owner and/or Construction Manager with monthly statistics concerning jobsite man-hours (by trade and those involving overtime), accident and severity information. This information will be submitted with the contractor’s monthly payment application. Failure to provide this information may delay payment to the affected contractor(s).

6. Each Contractor and Sub-contractor shall observe all applicable federal, state and local laws and regulations pertaining to safety and health, pollution control, water supply, fire protection, sanitation facilities, waste disposal and other related items.

7. Each Contractor and Sub-contractor shall cooperate fully with all other contractors in their respective safety and health programs.

8. The Contractor or Sub-contractor shall furnish all reasonable information concerning the safety of their operations on the project as may be required by the Construction Manager.

9. The Contractor shall notify the Construction Manager, as soon as practical, of all injuries requiring clinical attention or property damage that is estimated to exceed $1,000.00.

10. Each Contractor shall be expected to indoctrinate employees and Sub-contractors on safety and health requirements, and enforce adherence to safe work procedures.

11. The Contractor will assign an individual to act as Safety Representative* who will have the responsibility of resolving safety matters, and act as a liaison among Contractors, the Construction Manager and the Owner. This individual must be on site and have the authority necessary to immediately correct unsafe practices or hazardous conditions. This representative or an alternate is also required to attend periodic safety meetings as directed by the Construction Manager.

   * The Safety Representative must be a competent person who is capable of identifying existing and predictable hazards in surroundings that are unsanitary, hazardous or dangerous to employees, and has the authority to take prompt corrective measures to eliminate them.

12. All Contractors will give full cooperation to the Owner’s and the Construction Manager’s representatives, who may periodically visit the project.
13. The Contractors will inform the Construction Manager of any federal or state inspection prior to the site tour. The Construction Manager will receive copies of all federal and state inspection reports, citations, penalties, abatement dates, etc.

14. Contractors or their employees or agents involved in unsafe acts or conditions may be directed to cease that activity until the condition is brought into compliance with the site safety procedures. These costs will be borne by the non-complying Contractor, and no costs will be charged to the Owner or the Construction Manager. In addition, if a Contractor or Subcontractor refuses to correct unsafe conditions, the Construction Manager may correct the situation by using other employees and backcharging the Contractor or Subcontractor for expenses incurred. Contractors or their Sub-contractors’ non-complying employees may be prohibited from working on the site at the sole discretion of Construction Manager, without recourse.

15. Failure to comply with the contract safety requirements will be considered as non-compliance with the contract, and may result in remedial action including withholding of payment of any sums due the Contractor.

16. **Additional Contract Safety Requirements**
   a. Personal Protective Equipment/Proper Work Clothing.
      • Clothing shall be appropriate to the duties being performed.
      • Hard hats shall be worn at all times while on the construction site with the bills in the forward position unless wearing the hard hat in the reverse is essential to the job function being performed, such as layout/survey work.
      • Safety glasses shall be worn at all times while on the construction site.
      • Work shoes/boots shall be first grade, hard soles and ankle high. Tennis shoes, gym shoes and sandals are prohibited.
      • Shirts shall be work at all times. Shirts shall be full length and have a 4 inch sleeve covering the shoulder.
      • Pants shall be boot length. Cuffed or torn pants are not recommended.
      • Gloves shall be worn when handling debris, old lumber and rough or sharp edged materials.
      • Hearing protection shall be worn when exposed to noise hazards.
   b. It will be the responsibility of each Contractor and Sub-contractor to ensure that all employees wear durable work boots. Under no conditions, shall tennis shoes or sandals be allowed. Other appropriate personal protective equipment shall be provided and worn as required.
   c. Fall Protection
      • Contractor shall provide it's workers fall protection for all work performed at elevations 6-foot or more above lower levels and at any elevation when performing work above hazardous equipment, materials, and chemicals.
         - Exceptions: Scaffold erection and dismantling, overhand bricklaying.
      • Roofing: Positive fall protection methods (guard rail systems, personal fall arrest systems, etc.) shall be used to eliminate fall hazards for those persons working on sloped roofs. Warning line systems shall not be used as fall protection on sloped roofs. The use of “Safety Monitors” for fall protection is not permitted. Warming line systems shall only be used on flat roofs. Persons working outside the warning lines, between the edge of the roof and the warning line shall be protected from fall hazards by positive fall protection methods.
   d. Radios are not permitted to have a volume louder than 65 decibels at the speakers. This is approximately the level of a normal conversation. Walkman type radios with earphones are not permitted.
e. Good housekeeping shall be observed at all times. Waste, debris and garbage shall be removed daily, or placed in appropriate waste containers. All materials, tools and equipment shall be stored in a safe and orderly fashion.
f. If a contractor must remove cables, barricades, or any other safety related item in order to perform their work, it shall be the responsibility of that contractor to replace each time they leave the area and when their work is completed. Failure to comply with this directive may result in Construction Manager performing this work at the contractor’s expense.
g. All Extension cords, cable and hoses shall be maintained at least 6’ 6” above the working floor. Where this is impossible, these items shall be inspected daily for damage and repaired immediately or tagged and removed from use until repaired. Failure to properly repair cords in a timely manner may result in confiscation of damaged cords by Construction Manager or a designated party.
h. Each Contractor or Sub-contractor will supply the proper equipment, take the necessary precautions to maintain the equipment according to current regulations and specifications, and accept responsibility to ensure that the necessary safety equipment is supplied and used when required.
i. All scaffolds must be checked daily and before each use for safety compliance. No scaffold shall be left at anytime in an unsafe condition and must be removed/disabled immediately if not to be used again.
j. Eight foot scaffold plank must be cleated or otherwise secured from movement.
k. Each Contractor and Sub-contractor is responsible for supplying, maintaining and inspecting all fire extinguishers in their office, storage, heating, burning/welding and refueling areas. In the event a fire extinguisher is discharged or damaged, it shall be removed from service and replaced with a charged unit. Type ABC 20 lb. fire extinguishers are a minimum requirement in these locations.
l. Hardhats must not be removed to use welding shields. Welding shields must attach to hardhats or be hand held.
m. No fire extinguisher shall be removed or discharged except for fighting a fire. Anyone discharging an extinguisher as a prank, or attempting to remove one from the site, shall be subject to immediate dismissal.
n. Only fire retardant materials may be used to build shanties or other temporary enclosures inside of buildings finished or under construction. Shanties shall be continually policed by their occupants to prevent the accumulation of waste food and combustibles such as lunch wrappers and newspapers in and around their shanty.
o. All tarps and blankets shall be made of fire retardant materials.
p. Riding the headache ball is not permitted.
q. Metal ladders are not permitted.
r. Class III (household) stepladders are not permitted.
s. Silica Exposures: Cutting Concrete, Masonry and Stone
   • Wet cut methods shall be used to control dust when cutting concrete, masonry products and stone. Dry cutting shall only be permitted when wet cutting methods will distort the appearance of the final finished work. When dry cutting methods are utilized the Subcontractor shall take all precautions necessary to protect its workers and any persons working in the area from exposure to dust created by dry cutting.
t. All dozers, loaders, tractors and endloader backhoes must have functioning backup alarms at all times. Persons working in or near the area of moving equipment shall wear high visibility clothing.
u Contractors shall maintain a minimum ½ hour fire watch after welding, cutting, and burning activities are completed.

17. Safety Orientation for Contractor Supervision

a. All Contractors and Sub-contractors shall have their site supervisor and/or safety representative at the pre-construction safety meeting to review and agree to the following:

   Safety procedures at the project
   Safety orientation and meetings for all trades (schedule and methods to be used)
   Record keeping requirements for inspections, violations, and variances
   Employee complaint and discipline
   Accident report and emergency procedures
   Sanitation and water supply system
   Tagging and lockout system procedures

b. This meeting will be documented and signed by the representative of each company present.

18. Clean-up

a. Each Contractor and Sub-contractor shall be responsible for daily clean-up and removal of debris and waste related to the scope of work.

b. Each Contractor shall include cost of and be responsible for clean-up and removal from the site of their identifiable debris including, but not limited to bulk debris, packaging, containers, unused materials and equipment, and materials unsuitable for disposal by standard commercial procedures (i.e., masonry and concrete materials, crates, combustible items, etc.).

c. If any Contractor or Sub-contractor fails to maintain a satisfactory clean-up program, the Construction Manager will give a 24 hour notice, perform the clean-up, and backcharge the responsible Contractor for the costs.

d. The Construction Manager will have the option to perform all clean-up on the project. If this option is exercised, the amount included will be deducted from the Contractor’s bid, and the Construction Manager will be responsible for all clean-up including identifiable debris.

C. CONTRACTOR PERSONNEL

1. All Contractor personnel are to know the safety rules listed on the Project Safety Guide. If a tradesperson does not understand the rules, he or she should ask his or her foreman or supervisor for help. Each tradesperson is responsible for following these rules without exception.

2. Tradespeople are to report any unsafe act or condition immediately to their foreman or supervisor. If the act or condition can be easily corrected, the tradesperson should make the correction.

3. Tradespeople should attend all required safety meetings. Basic safety orientations for each trade are mandatory in addition to Weekly Tool Box meetings and periodic specialty training.
4. Tradespeople should report all work related injuries and illnesses to their supervisor immediately.

5. Never sacrifice safety for production. Proper construction technique and good common sense will prevent most accidents.

D. THE CONSTRUCTION MANAGER

1. The Construction Manager does not assume the safety responsibilities of the Contractors as set forth under OSHA Regulations:

2. Each employer has a general duty to furnish each employee with a place of employment free from recognized hazards causing, or likely to cause death or serious physical harm.

3. The Construction Manager will act as a consultant to assist the Contractors in meeting the minimum basic standards as set forth by OSHA and the Construction Manager Project On-site Safety and Loss Program. Each Contractor and Subcontractor is responsible for the means and methods associated with application and implementation of safety related matters.

4. **Safety Hazard Notifications** shall be issued to the contractor when an unsafe act or condition is reported or observed. The Construction Manager will monitor the abatement or associated reprimand of unsafe acts or conditions within a Contractor's scope of work.

5. Coordination between Contractors on safety related items or disputes will be at the discretion of the Construction Manager.

2.03 PROCEDURES

A. HAZARD ABATEMENT

1. The following sequence of actions should be taken in the event of unsafe acts or conditions on the jobsite. The order of action is suggested, but not necessary, if the situation requires immediate abatement to avoid an accident. Sound judgment must be exercised in dealing with potential problems as opposed to imminent dangers.

2. **Unsafe Acts & Conditions**
   If unsafe acts or conditions are observed within a Contractor’s area of control, the Contractor's supervisor in charge of the area is to be contacted. If corrective action is taken immediately, the matter will be noted in the Superintendent's Daily Report. If corrective action is not taken immediately by the supervisor in charge, the Contractor's management will be issued a Safety Hazard Notification.

3. **Safety Hazard Notification**
   If immediate action is not taken or a dispute over the hazard develops, a Safety Hazard Notification will be issued. This form will be specific in noting the acts or conditions that do not meet minimum standards for safety and health. The Contractor should take immediate steps to correct the hazard(s). Corrective action
taken by the Contractor shall be noted on the Safety Hazard Notification Form, and the form returned to the Construction Manager to avoid remedial action.

4. Remedial Action

If corrective action is not taken, a letter or telegram is to be sent to the Contractor’s Chief Executive Officer requesting immediate attention. The letter or telegram will outline remedial action to be taken by the Construction Manager, if corrections are not made. Note that all costs will be charged to the Contractor, and any action taken by the Construction Manager will not relieve the Contractor of responsibility for safety.

B. ACCIDENT MANAGEMENT

1. First Aid Treatment

The Contractor shall have standard emergency procedures to deal with the immediate removal and treatment, if necessary, of any employee who may be injured or become ill. The Contractor shall keep on the job a first-aid kit supplied according to current regulations, and shall have a person trained in first aid.

A copy of the First-Aid Certificate must be submitted to the Construction Manager.

2. Accident Reports:

Personnel

If an employee of a Contractor is injured and requires treatment at a clinic, the contractor shall provide the Construction Manager with a written report of the occurrence. The Contractor may furnish a copy of the First Report of Injury or utilize Construction Manager’s Accident Data Report form. This report is required within 24 hours of the injury.

All recordable occupational injuries and illnesses, other than first aid cases as defined by the Occupational Safety and Health Act of 1970, shall be documented by the Contractor on an OSHA Injury Log (Form 300), and a copy should be forwarded monthly to the Construction Manager.

Severe Injuries or Accidents

The Contractor shall notify the Construction Manager immediately of any severe injury or accident in which one or more persons may be hospitalized, or property damage is estimated in excess of $1,000.00. Use the Construction Manager Accident Data Report to report.

3. Loss Incident Reports

Any incident involving a Contractor and/or the public property or vehicle of another must be reported within 24 hours. This report shall be submitted on the Construction Manager Loss Incident Report Form. Alternate forms may be substituted, if approved by the Construction Manager.

C. PERSONNEL SAFETY ORIENTATION
1. Each Contractor shall comply with OSHA Regulation 1926.21(2), which states that the employer shall instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to the work environment.

2. **Basic Safety Orientation**
   
   All trades personnel that work on this project shall attend a basic safety orientation, either through their own company or the Construction Manager. Attendance is mandatory, and records shall be kept of all attendees. The focus of this orientation shall be the Project Safety Guide (Paragraph 2.04 of this Section), and specifically the basic safety rules and employee responsibilities. Each attendee shall receive a copy of the project Safety Guide for future reference.

3. **Safety Orientation**
   
   In addition to the basic safety orientation, the Contractor shall provide each employee with a trade safety orientation before beginning work. This orientation shall include trade specific rules, potential hazards in the Contractor’s area of control, and the use of personal protective equipment. Attendance at this orientation is also mandatory, and may be included with the basic safety orientation meeting, if both are conducted by the Contractor.

D. **TOOL BOX SAFETY MEETING**

1. The Contractor shall hold weekly Tool Box safety training meetings for all of their employees. All trades personnel are required to attend these weekly training sessions. These sessions must be documented on the Weekly Tool Box Talk forms and returned to the Construction Manager on a weekly basis. These are required, and monies will be withheld until they are on file. Alternate forms must be approved by the Construction Manager.

2. **Self Inspection**
   
   To provide current and effective safety information, a self-inspection of the Contractor’s area of control should be performed prior to the Tool Box Talk meeting. The Contractor’s safety representative or supervisor should tour the area, noting safety problems or deficiencies on the Tool Box Talk form. Dates for action taken on the deficiencies must be set prior to submittal to the Construction Manager.

3. **Tool Box Meeting**
   
   When utilizing the Tool Box Talk form, the Contractor should note the meeting date, leader and topics discussed, in addition to signatures of all employees in attendance. Five minutes is the optimum time for the meeting. The tone of all safety discussions should be serious and purposeful.

2.04 PROJECT SAFETY GUIDE

A. **SAFETY ORIENTATION**

1. **Orientation**
   
   New employees will be given a talk about safety during orientation. This is not intended to be completely comprehensive. Failure to include any given item does not relieve the Contractor of the responsibility as to that item.
2. Orientation for New Employees

This company is very serious about Safety. We want you to also think seriously about safety - both your own safety and the safety of others.

Safety is the responsibility of every employee. Most injuries occurring in our industry are preventable. One does not need to suffer an injury trying to get a job done. When you see an unsafe act or an unsafe condition, correct it yourself immediately or ask your supervisor for help in getting it corrected. If you have any problems, such as dizziness, trouble breathing, bad back, fainting spells, personal problems, etc., which could affect your work, let your supervisor know about it. Your supervisor needs to know, so you will not be placed in a situation where you could hurt yourself or others.

Safety is accomplished through effective communication, sincere desire, honest effort, common sense and support by everyone. Merely talking about safety does not prevent accidents.

Your supervisor will hold weekly safety training meetings for the entire crew. You are required to attend. Participate in the meeting. Contribute your “know-how” to the less experienced, and ask questions if you do not understand.

Learn the material in this booklet that pertains to your work. Refer to this material and to your supervisor before starting any task that may be unfamiliar to you. Be aware of other activities nearby that may create hazards to you, or which may affect your work.

Compliance to safety rules and regulations under the Federal Occupational Safety and Health Act of 1970 is mandatory. Violations will be treated as a serious issue.

B. GENERAL SAFETY RULES

ALL OF OUR SAFETY RULES MUST BE OBEYED. FAILURE TO DO SO WILL RESULT IN STRICT DISCIPLINARY ACTION.

1. Keep your mind on your work at all times. No horseplay on the job. Injury, termination or both may be the result.

2. Personal Protective Equipment/Proper Work Clothing.
   - Clothing shall be appropriate to the duties being performed.
   - Hard hats shall be worn at all times while on the construction site with the bills in the forward position unless wearing the hard hat in the reverse is essential to the job function being performed, such as layout/survey work.
   - Safety glasses shall be worn at all times while on the construction site.
   - Work shoes/boots shall be first grade, hard soles and ankle high. Tennis shoes, gym shoes and sandals are prohibited.
   - Shirts shall be work at all times. Shirts shall be full length and have a 4 inch sleeve covering the shoulder.
   - Pants shall be boot length. Cuffed or torn pants are not recommended.
   - Gloves shall be worn when handling debris, old lumber and rough or sharp edged materials.
Hearing protection shall be worn when exposed to noise hazards.

3. Fall protection is required when the walking or working surface is 6 foot or more above the next lower level, or when working above hazardous equipment, materials, chemicals and processes regardless of the height.

4. If any part of your body should come in contact with an acid or caustic substance, rush to the nearest water available and flush over the affected part. Secure medical aid immediately.

5. Watch where you are walking. Do not run.

6. The use of illegal drugs or alcohol or being under the influence of the same on the project shall be cause for termination. If you take or are given strong prescription drugs that warn against driving or using machinery, let your supervisor know about them.

7. Do not distract the attention of fellow workers; it may cause injury.

8. Sanitation facilities have been or will be provided for your use. Defacing or damaging these facilities is forbidden.

9. A good job is a clean job, and a clean job is a safe one. So keep your working area free from rubbish and debris.

10. Do not use a compressor to blow dust or dirt from your clothes, hair, face or hands.

11. Never work aloft if you are afraid to do so, subject to dizzy spells, or apt to be nervous or sick.

12. Never move an injured person unless it is absolutely necessary. Further injury may result. Keep the injured as comfortable as possible and utilize jobsite first-aid facilities until a doctor arrives.

13. Know where fire fighting equipment is located and learn how to use it.

14. Learn to lift correctly - with the legs and not the back. If the load is too heavy, GET HELP. 20% of all construction related injuries result from lifting materials.

15. Riding on loads, fenders, running boards, sideboards and gates, or with your legs dangling over the ends or sides of trucks will not be tolerated.

16. Do not use power tools and equipment until you have been properly instructed in safe work methods and become authorized to use them.
   - Tools shall inspected before each use and all damaged or worn parts are to be promptly replaced and or repaired.
   - Tools not in acceptable condition are to be brought to the attention of your supervisor, and shall be removed from service and tagged “Defective Do Not Use”.
   - Tools shall be used in accordance with the manufacture’s recommendations.
   - Guards on tools shall not be removed or rendered inoperable.
   - Powder actuated tools are to be used by qualified personnel who have been instructed and trained in their safe use.
   - Hand tools shall only be used for what they are intended for.
   - When employees are required to provide personal tools, those tools shall be safe and in good working order.

17. Be sure that all guards are in place. Do not remove, displace, damage or destroy any safety device or safeguard furnished or provided for use on the job, nor interfere with the use thereof.
18. Do not enter an area that has been roped off or barricaded.

19. If you must work around power shovels, cranes, trucks and dozers, make sure operators can always see you.

20. Never oil, lubricate or fuel equipment while it is running or in motion.

21. Rope off or barricade danger areas.

22. Keep away from the edge of cuts, embankments, trenches, holes and/or pits.

23. Excavations and Trenches
   • No employee is to enter a trench 5 foot or more in depth unless it is protected from cave-in by one or more of the following means: sloped (laid back), shored, sheeted, boxed, or by an engineered system designed to prevent cave-in.
   • A competent person shall inspect excavations or trenches, adjacent areas and protective systems daily or as required by changing conditions before employees are permitted to enter the excavation or trench.
   • An access/egress ladder hall be placed in trenched 4 or more foot in depth and shall not be more that 25 feet from those working in the trench.

24. Use the “four and one” rule when using a ladder. One foot of base for every four feet of height.

25. Always secure the bottom of the ladder with cleats and/or safety feet. Lash off the top of the ladder to avoid shifting.

26. Ladders must extend three feet above a landing for proper use.

27. Defective ladders must be properly tagged and removed from service.

28. Keep ladder base free of debris, hoses, wires, material, etc.

29. Build scaffolds according to manufacturer’s recommendations.

30. Scaffold planks must be cleated or secured to prevent them from sliding.

31. Not Used

32. The use of safety belts/harnesses and lanyards securely attached to an approved anchorage point when working from unprotected high places is mandatory. Always maintain less than six feet of slack in your lanyard.

33. Never throw anything “overboard.” Someone passing below may be seriously injured.

34. Tar kettles must be kept at least twenty-five feet from buildings or structures, and never on the roofs.

35. Open fires are prohibited.

36. Do not use any hazardous material until you have been properly instructed and authorized to use it.

37. Know what emergency procedures have been established for your jobsite. (Locations of emergency phone, first-aid kit, blood borne pathogens kit, stretcher, fire extinguishers, evacuation plan, etc.)

38. Notify your supervisor of unlabeled or suspected toxic substances immediately and avoid contact.
The information contained herein in no way relieves suppliers or Contractors of their lawful or contractual responsibilities and obligations for safety. Suppliers and/or Subcontractors should seek professional guidance (legal/safety) in developing their own safety rules and programs.

39. Electrical:
- No work shall be permitted on live electrical parts – power sources are to be de-energized and when required “locked and tagged” out of service.
- Electric powered tools shall be plugged into a circuit that is protected by a ground fault circuit interrupter.
- The tool and its cord (including extension cord) are to be inspected for damage prior to use. Damaged tools and cords shall be removed from service and tagged “DEFECTIVE DO NOT USE”.
- No work shall be permitted within 10 feet of power transmission lines rated up to 50kv. For work near transmission lines greater than 50kv, increase the 10 foot distance ½ foot for every 1kv over 50kv. (Note: when working in inclement weather, additional precautions may be required.)

40. Cranes and Hoisting
- An authorized operator shall inspect hoisting equipment and rigging before use each day.
  o Defective equipment shall be immediately removed from service. Equipment requiring repair shall be labeled “Danger! Out of Service”.
  o Rigging such as slings, chokers, shackles, etc., shall be tagged “Defective! Do Not Use”. It is recommended that defective rigging be rendered unusable (cut up) and disposed of.
  o Employees are prohibited from removing defective rigging equipment from the project site for home use or any other uses.
- Only persons knowledgeable in proper hand signals shall be designated as a signal person. When using hand signals, only one person shall signal the crane operator.
- Tag Lines shall be used when raising or hoisting materials or equipment.
- Loads should not be swung over workers.
- Riding loads or crane hook is prohibited.

2.05 - SAFETY RELATED FORMS

A. The CM, A/E, and Owner reserve the right to request and receive from the contractors at any time, forms used during safety meetings that include but are not limited to the following:
  a. Contractor Pre-Construction Safety Meeting Agenda
  b. Safety Statistics Report Form
  c. Notice of Safety Non-Compliance Form
  d. Weekly Tool Box Talks Form
  e. Accident/Near Miss Investigation Report Form
  f. Equipment Safety Inspection Report
  g. Forklift Safety Inspection Report Form
  h. Scaffolding Inspection Report Form
  i. Assured Equipment Grounding Program Form
END OF SECTION 019500
VOLUME 02

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SECTION 013400 - SHOP DRAWINGS, PRODUCT DATA & SAMPLES

PART 1 - GENERAL

1. RELATED DOCUMENTS

All provisions of the Contract Documents apply to this Section. The Contractor(s) shall be responsible for complete familiarity of same.

2. REQUIREMENTS INCLUDE

A. Procedures for submittals.

3. SHOP DRAWINGS

A. Present in a clear and thorough manner. Title each drawing with project and contract name and number; identify each element of drawings by reference to sheet number and detail, schedule or room number of Contract Documents.

B. Identify field dimensions, show relation to adjacent or critical features of work or products.

C. Minimum Sheet Size: 11" x 17" or multiples of 8-1/2" x 11".

D. Reproduction of Contract Documents are not acceptable as shop drawings.

E. ALL Shop Drawings shall be submitted in a digital format (pdf).

F. Each Shop Drawing shall include a copy of Architect’s Shop Drawing Submittal Form with all applicable information completed by contractor.

4. PRODUCT DATA

A. Submit only pages which are pertinent; mark each copy of standard printed data to identify pertinent products, referenced to Specification Section and Article number. Show reference standards, performance characteristics and capacities, wiring and piping diagrams and controls, component parts, finishes, dimensions and required clearances.

B. Modify manufacturer's standard schematic drawings and diagrams to supplement standard information and to provide information specifically applicable to work. Delete information not applicable.

5. SAMPLES

A. Submit full range of manufacturer's standard finishes except when more restrictive requirements are specified, indicating colors, textures and patterns for Architect selection.

B. Submit samples to illustrate functional characteristics of products, including parts and attachments.

C. Approved samples which may be used in the work area indicated in specification sections.
D. Label each sample with identification required for transmittal letter.

E. Provide field samples of finishes at project, at location acceptable to Architect, as required by individual specification sections. Install each sample complete and finished. Acceptable finishes in place may be retained in completed work.

F. Submit for approval two (2) samples, or as otherwise required by the specifications.

6. MANUFACTURER'S INSTRUCTIONS

A. Manufacturer's instructions for storage, preparation, assembly, installation, start-up, adjusting, balancing and finishing.

7. CONTRACTOR REVIEW

A. Review submittals prior to transmittal, determined and verify field measurements, field construction criteria, manufacturer's catalog numbers, and conformance of submittal with requirements of contract documents.

B. Coordinate submittals with requirements of work and of contract documents.

C. Sign or initial each sheet of shop drawings and product data and each sample label to certify compliance with requirements of contract documents. Notify Architect in writing at time of submittals, of deviations from requirements of contract documents. IT IS NOT ARCHITECT OR ENGINEER RESPONSIBILITY TO REVIEW FINAL DIMENSIONS OR QUANTITIES. APPROVAL OF A SHOP DRAWING DOES NOT CONSTITUTE APPROVAL OF A DEVIATION FROM THE CONTRACT DOCUMENTS UNLESS SPECIFICALLY NOTED.

D. Do not fabricate products or begin work which requires submittals until return of submittal with Architect acceptance.

8. SUBMITTALS REQUIREMENTS

A. Transmit submittals in accord with approved Progress Schedule.

B. Include Architect’s Shop Drawing Submittal Form attached as the first page of each submittal. If this form is not used, the submittal will be returned without review.

C. Apply Contractor's stamp, signed or initialed, certifying to review, verification of products, field dimensions and field construction criteria, and coordination of information with requirements of work and contract documents.

D. Coordinate submittals into logical groupings to facilitate interrelation of several items:

   1. Finishes which involve Architect selection of colors, textures or patterns.

   2. Associated items which require correlation for efficient function or for installation.

E. All shop drawings shall be submitted in digital format. If hard copies are provided, Original submission of shop drawings as required by the contract shall be in the form of one set of
reproducible transparencies, such as ozalid, sepia and one set of prints. Standard mass produced items may be catalog cuts of which Contractor has had a reproducible transparency prepared, except in the instance of items especially adapted for this project.

F. Submit number of samples specified in individual specification sections.

G. Submit under Architect accepted form transmittal letter. Identify project by title and number, identify contract by number. Identify work and product by specifications section and article number.

H. Contractor shall submit copies of submittals to Owner at the same time the original submission is made to Architect – or follow procedure as directed by the Construction Manager.

I. During the checking of shop drawings, phone conversations with Contractors, etc., if any revisions are being made to the contract documents, make a written record for all revisions to the drawings/specifications (for Record Drawings/Record Addendum), note the revisions in red, on the stick set of drawings/specifications and file the written record in the "Record Drawing and Record Addendum" section of the job notebook.

9. RESUBMITTALS

A. Make resubmittals in accordance with requirements for initial submittals, clearly identify changes made since previous submittal.

B. A maximum of 2 resubmittals will be accepted at no cost to Contractor. Contractor shall be responsible for direct compensation to Architect or Engineer for resubmittals above and beyond 2. Hourly rate assessed will be $200/hour.

10. DISTRIBUTION

A. Duplicate and distribute reproductions of shop drawings, copies of product data and samples, which bear Architect stamp of approval, to job site file, Record Documents file, subcontractors, suppliers, other affected Contractors, and other entities requiring information.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION
SECTION 01 57 19 – INDOOR AIR QUALITY (IAQ) MANAGEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes special requirements for Indoor Air Quality (IAQ) management during construction operations.
   1. Control of emissions during construction.
   2. Control of moisture during construction.

B. Procedures for testing baseline IAQ. Baseline IAQ requirements specify maximum indoor pollutant concentrations for acceptance of the facility.

C. Related Sections:
   1. Administrative requirements – Ref: Section 01 31 00.
   2. Project meetings – Ref: Section 01 31 00.
   3. Submittal requirements – Ref: Section 01 33 00.
   4. Quality assurance testing - Ref: Section 01 45 00.
   5. Closeout documentation, cleaning, and final submittals – Ref: Section 01 77 00.

1.2 DEFINITIONS

A. Adequate ventilation: Ventilation, including air circulation and air changes, required to cure materials, dissipate humidity, and prevent accumulation of particulates, dust, fumes, vapors, or gases.

B. Hazardous Materials: Any material that is regulated as a hazardous material in accordance with 49 CFR 173, requires a Material Safety Data Sheet (MSDS) in accordance with 29 CFR 1910.1200, or which during end use, treatment, handling, storage, transportation or disposal meets or has components which meet or have the potential to meet the definition of a Hazardous Waste in accordance with 40 CFR 261. Throughout this specification, hazardous material includes hazardous chemicals.
   1. Hazardous materials include: pesticides, biocides, and carcinogens as listed by recognized authorities, such as the Environmental Protection Agency (EPA) and the International Agency for Research on Cancer (IARC).

C. Indoor Air Quality (IAQ): The composition and characteristics of the air in an enclosed space that affect the occupants of that space. The indoor air quality of a space refers to the relative quality of air in a building with respect to contaminants and hazards and is determined by the level of indoor air pollution and other characteristics of the air, including those that impact thermal comfort such as air temperature, relative humidity and air speed.
D. Interior final finishes: Materials and products applied within the vapor barrier of the building that will be exposed at interior, occupied spaces; including (but not limited to) flooring, wall covering, finish carpentry, and ceilings.

E. Packaged dry products: Materials and products that are installed in dry form and are delivered to the site in manufacturer's packaging; including carpets, resilient flooring, ceiling tiles, and insulation.

F. Wet products: Materials and products installed in wet form, including paints, sealants, adhesives, special coatings, and other materials which require curing.

1.3 SUBMITTALS

A. Submit Indoor Air Quality (IAQ) Management Plan: Not less than 10 business days prior to the beginning of ANY CONSTRUCTION ACTIVITY, prepare and submit an IAQ Management Plan including, but not limited to the IAQ management criteria found in PART 3- EXECUTION.

1. Revise and resubmit IAQ Management Plan if requested by Heapy Engineering to ensure planned LEED credits will be attained.

   a. Approval of Contractor’s Plan will not relieve the Contractor of responsibility for compliance with applicable environmental regulations and ongoing performance.

B. Photograph Documentation: Photographs must be taken at 10 or more different instances throughout construction of all 5 IAQ measures mentioned in Section 2.1 to demonstrate that SMACNA IAQ guidelines have been followed.

C. Submit Product Data:

1. Submit product data for filtration media to be used during construction and prior to occupancy. Include Minimum Efficiency Reporting Value (MERV).

D. With each application for payment, submit a narrative along with available photographs demonstrating how the project has complied with each section of the Construction IAQ Management Plan. By the completion of the project, the team will need to have provided, in sum, a minimum 10 photographs of 10 different locations on at least 3 different occasions during construction (30 total photos with three different timestamps For each of the 3 different occasions, 2 photographs of each of the IAQ measures described in Part 2 – EXECUTION below. Each photo must include a brief description of the SMACNA approach employed, documenting implementation of the IAQ management measures, such as protection of ducts and on-site stored or installed absorptive materials.

1.4 MEETINGS

A. Pre-construction meeting – As part of the Pre-construction meeting, discuss the proposed IAQ Management Plan and to develop mutual understanding relative to details of environmental protection. Record discussions and agreements and furnish copy to each participant. Provide at least 72 hours' advance notice to participants before holding the Pre-construction meeting.
2- EXECUTION

2.1 IAQ MANAGEMENT CRITERIA

A. During construction meet or exceed the recommended Control Measures of the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction Second Edition – November 2007 Chapter 3.

B. HVAC Protection:
   1. HVAC system should be protected from both dust and odors and all ducts and equipment openings sealed with plastic.
   2. Provide temporary exhaust during construction operations.
   3. The return/negative pressure side of the system should be protected if system must be operated. To the greatest extent possible, isolate and/or shut down the HVAC system during construction. When ventilation system must be operational during construction activities, provide Minimum Efficiency Reporting Value (MERV) 8 or greater temporary filtration as determined by ASHRAE 52.2-1999 on all return air grilles.
   4. Replace all filtration media just before occupancy.

C. Source Control: Architect or designer should specify finish materials which contain low or no toxicity levels. Containers housing toxic materials should be recovered, isolated and ventilated. Provide materials and products with low pollutant emissions as specified.
   1. Potential sources of Volatile Organic Compound (VOC) emissions include the following:
      a. Paints, stains, and varnishes.
      b. Solvents.
      c. Adhesives and wood preservatives.
      d. Waxes, polishes, and cleansers.
      e. Lubricants and sealants.
      f. Fuels.
      g. Plastics.
   2. Potential sources of Combustion Contaminants include the following:
      a. Furnaces and generators.
      b. Gas or kerosene space heaters.
      c. Tobacco products.
      d. Vehicles.
   3. Potential sources of Formaldehyde Contaminants include the following:
      a. Particle board and plywood.
      b. Cabinetry.
      c. Insulation.
   4. Potential sources of Particle and Fiber Contaminants include the following:
a. Paper printing and handling.
b. Insulation.
c. Vacuuming and cleaning of construction areas.

D. Pathway Interruption: Isolate areas of work as necessary to prevent contamination of clean or occupied spaces. During installation of materials containing VOCs ventilate or exhaust contaminated air with or to outside air. Provide pressure differentials and/or physical barriers to protect clean or occupied spaces to contain construction. If temporary measures are installed including, but not limited to; plastic sheeting, ensure proper sealing of all potential gaps and areas of potential ongoing disturbance, such as corridors and entry or access points.

E. Housekeeping: During construction, maintain project and building products and systems to prevent contamination of building spaces.
   1. Keep materials dry and store in a clean area. Protect stored on-site and installed absorptive materials from moisture damage; keep such materials off of unconditioned slabs and floors.
   2. Verify that installed materials and products are dry prior to sealing and weatherproofing the building envelope.
   3. Install interior absorptive materials only after building envelope is sealed and weatherproofed.
   4. Use vacuum with high efficiency particulate filters and wetting agents for dust.

F. Scheduling: Coordinate construction to limit disruption of operations in occupied portions of building. Plan enough time for flush out and IAQ test procedures before occupancy. Schedule construction operations involving wet products prior to packaged dry products to the greatest extent possible.
   1. Weather-proof as quickly as possible. Schedule installation of moisture-control materials, including but not limited to air barriers, flashing, exterior sealants and roofing, at the earliest possible time.
   2. Schedule work such that absorptive materials, including but not limited to porous insulations, paper-faced gypsum board, ceiling tile, and finish flooring, are not installed until they can be protected from rain and construction-related water.

2.2 POST-CONSTRUCTION IAQ MEASURES

A. The General Contractor will be contracting a firm to perform IAQ Testing with the intent of meeting the requirements of LEED ID+C v3.0 EQc3.2. The General Contractor must provide allowances in the construction schedule to allow for testing to be completed prior to planned occupancy date. Testing cannot occur until all interior finishes are installed and punch lists are complete. Anticipated duration of testing shall be confirmed with Owner during schedule development.

B. OR General Contractor to provide a building flushout with the intent of meeting the requirements of LEED ID+C v3.0 EQc3.2. The General Contractor must provide allowances in the construction schedule to allow the flushout to be completed prior to planned occupancy date. The building flushout cannot occur until all interior finishes are installed and punch lists are complete. Supply a total air volume of 14,000 cu. ft. of outdoor air per square foot of floor while maintaining an internal temperature of at least 60 degrees F and relative humidity no higher than 60%. Anticipated duration of testing shall be confirmed with Owner during schedule development. The General Contractor is required to submit a letter describing the
flush-out dates, outdoor air delivery rates (if different than minimum outside air operation of each system), internal temperature, and relative humidity.

END OF SECTION 01 57 19
SECTION 01 74 19 – CONSTRUCTION WASTE MANAGEMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
   1. Special requirements for waste management during demolition and construction operations.
      a. Protect the environment, both on-site and off-site, during demolition and construction operations.
      b. Prevent environmental pollution and damage.
      c. Maximize source reduction, reuse and recycling of solid waste.

B. Related Sections:
   1. 01 30 00 – Administrative Requirements: Environmental Manager and Contractor training requirements.
   2. 01 40 00 – Quality Requirements: Meetings and project coordination.
   3. 01 81 13 – Sustainability Requirements.

1.2 DEFINITIONS

A. Definitions pertaining to sustainable development: As defined in ASTM E2114.

1.3 QUALITY ASSURANCE

A. Maximize use of source reduction and recycling procedures outlined in ASTM D5834.
B. Diversion Goals: The project goal is to divert 75% by weight or volume. An innovation in design point can be earned if 95% is diverted.

1.4 PRECONSTRUCTION MEETING

A. After award of Contract and prior to the commencement of the Work, schedule and conduct meeting with Owner and Architect to discuss the proposed Waste Management Plan and to develop mutual understanding relative to details of environmental protection.

1.5 SUBMITTALS

A. Solid Waste Management Plan: Within seven business days of the Preconstruction Meeting prepare and submit a Construction Waste Management Plan including, but not limited to, the following:
   1. List of the recycling facilities, reuse facilities, municipal solid waste landfills and other disposal area(s) to be used. Include:
      a. Name, location, and phone number.
      b. Copy of permit or license for each facility.
2. Identify materials that cannot be recycled or reused. Provide explanation or justification.

3. Documentation form to be used for progress documentation and record submittal.

4. Revise and resubmit Plan if required per LEED program manager review comments to ensure attainment of planned LEED Credits.
   a. Approval of Contractor’s Plan will not relieve the Contractor of responsibility for compliance with applicable environmental regulations and ongoing performance requirements.

B. Progress Documentation: Document solid waste disposal and diversion performance by submitting a monthly construction waste progress report and associated waste tickets by both weight and volume for all diverted, recycled, and non-diverted waste. Include the quantity by weight of waste generated; waste diverted through sale, reuse, or recycling; and waste disposed by landfill or incineration. Identify landfills, recycling centers, waste processors, and other organizations that process or receive the solid waste.

   1. Document on form in Appendix A of this Section, or similar form as approved by Owner and LEED Program Manager.
   2. With each Application for Payment, submit updated Documentation for solid waste disposal and diversion performance.
   3. With each Application for Payment, submit manifests, receipts, waste tickets by both weight and volume for all diverted, recycled, and non-diverted waste, and invoices specifically identifying the Project and waste material.

C. Record Submittals: Submit the following:

   1. Summary of solid waste disposal and diversion. Submit on form in Appendix A of this Section, or similar form as approved by Owner.
   2. Waste tickets. Submit all waste tickets monthly. The Construction Manager is responsible for maintaining the tickets for the entire duration of the project. A final copy of the waste tickets shall be turned over to the LEED Project Manager upon project completion.

PART 2 EXECUTION

2.1 SOLID WASTE MANAGEMENT

A. Develop and implement a waste management program in order to meet the project goal of a minimum 75 percent by weight or volume of total project solid waste to be diverted from landfill as required by the LEED ID+C version 3.0 Rating System.

B. Collection: Implement a recycling/reuse program that includes either separate collection of waste materials onsite or commingled collection of waste materials sorted at an off-site facility. Collect waste materials of the following types as appropriate to the project waste and to the available recycling and reuse programs in the project area:

   1. Asphalt.
   2. Concrete and Masonry.
   3. Metal
   a. Ferrous.
b. Non-ferrous.

5. Debris (not including soil/land clearing debris).
7. Paper.
   a. Bond.
   b. Newsprint.
   c. Cardboard and paper packaging materials.

   a. Type 1: Polyethylene Terephthalate (PET, PETE).
   b. Type 2: High Density Polyethylene (HDPE).
   c. Type 3: Vinyl (Polyvinyl Chloride or PVC).
   d. Type 4: Low Density Polyethylene (LDPE).
   e. Type 5: Polypropylene (PP).
   f. Type 6: Polystyrene (PS).
   g. Type 7: Other. Use of this code indicates that the package in question is made
   with a resin other than the six listed above, or is made of more than one resin
   listed above, and used in a multi-layer combination.

10. Non-hazardous paint and paint cans.
11. Carpet.
12. Insulation.
13. Others as appropriate.

C. Recycling/Reuse: Maximize recycling and reuse of materials.

1. Recycling/Reuse on project site: As approved, noted or specified by Owner and
   Architect.
2. Recycling/Reuse off project site: Contact the State Department of Environmental
   Quality and/or the local Integrated Solid Waste Management Office.

D. Handling:

1. Clean materials that are contaminated prior to placing in collection containers.
   Deliver materials in accordance with recycling or reuse facility requirements (e.g.,
   free of dirt, adhesives, solvents, petroleum contamination, and other substances
   deleterious to recycling process).
2. Arrange for collection by or delivery to the appropriate recycling or reuse facility.
3. Hazardous Waste and Hazardous Materials: Handle in accordance with applicable
   regulations.

END OF SECTION 01 74 19
## CONSTRUCTION WASTE MANAGEMENT SPREADSHEET

<table>
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<tr>
<th>Container or Ticket number</th>
<th>Haul Date</th>
<th>CONTAINER SIZE</th>
<th>Total Tonnage (sum of concrete, metal, wood, other and residual)</th>
<th>Concrete Tonnage (diverted)</th>
<th>Metal Tonnage (diverted)</th>
<th>Wood Tonnage (diverted)</th>
<th>Paper and Cardboard Products Tonnage (diverted)</th>
<th>Other Diverted/Recycled Tonnage (diverted)</th>
<th>C &amp; D or Trash Tonnage (landfilled)</th>
<th>% Diverted Material</th>
<th>Name and location material was sent to. (If Other Recycled Material please also include description of material (E: Clean Green, Drywall, Glass, etc.)</th>
<th>Comments. If landfilled, please explain why material was not diverted. If large amount appears as &quot;Other&quot; please explain contents.</th>
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SUSTAINABILITY REQUIREMENTS

PART 1 – GENERAL

1.1 SUMMARY

A Section Includes:
1 Sustainable project goals
2 Sustainable product requirements

B Related Sections:
1 Section 01 57 19 – Indoor Air Quality Management
2 Section 01 74 19 – Construction Waste Management
3 Section 01 91 00 – Commissioning: General Commissioning Requirements
4 Section 23 08 00 – Commissioning of HVAC: Mechanical Systems Commissioning Requirements
5 Section 26 08 00: Electrical Systems Commissioning Requirements
6 Section 22 08 00: Plumbing Systems Commissioning Requirements
7 Individual specification sections for additional product requirements

1.2 DEFINITIONS

A LEED®: Leadership in Energy & Environmental Design.

B Recycled Content: The percentage by weight of constituents that have been recovered or otherwise diverted from the solid waste stream, either during the manufacturing process or after consumer use.

1 Post-consumer material is defined as waste material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose.
2 Pre-consumer material is defined as material diverted from the waste stream during the manufacturing process. Reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it are excluded.

C Local and Regional Materials: Materials that are manufactured, extracted, and processed within a radius of 500 miles from the project site

D Certified Wood: Wood certified by the Forest Stewardship Council (FSC). Vendors are defined as those companies that sell products to the project contractor or subcontractors (i.e. installing contractors). All vendors must have FSC Chain of Custody certification in order for any FSC products used on the project to qualify.

1.3 REFERENCES
American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 52.2-1999 – Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
2. ASHRAE 55-2004 – Thermal Comfort Conditions for Human Occupancy

ASTM International:


Carpet and Rug Institute:

1. CRI Green Label Program
2. CRI Green Label Plus Program

Efficiency Valuation Organization:

1. International Performance Measurement & Verification Protocol

Forest Stewardship Council:

1. FSC Guidelines – Forest Stewardship Council Guidelines

Green Seal:

1. GC-03 – Anti-Corrosive Paints
2. GS-11 – Paints

Sheet Metal and Air Conditioning Contractors:

1. SMACNA IAQ Guidelines for Occupied Buildings Under Construction, 1995, Chapter 3

South Coast Air Quality Management District:

1. SCAQMD Rule 1113, Architectural Coatings as of January
2. SCAQMD Rule 1168, Adhesive and Sealant Applications

U.S. Environmental Protection Agency:
1.4 SUSTAINABLE PROJECT GOALS

A LEED® Construction Project Goals: Refer to LEED® Rating System Project Checklist attached to this section for Sustainable Goals.

B Notify Owner and Architect/Engineer when conflicts arise between work performance and sustainable project goals.

1.5 SUBMITTALS

A The General Contractor shall be responsible for LEED® submittal requirements included in this section as well as other specification sections.

LEED® submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit one (1) duplicate copy to LEED Program Manager as a separate submittal to review LEED® related product info.

B The General Contractor shall provide a Schedule of Values (or similar document) indicating project cost data separated by labor and material for all items in CSI MasterFormat 2004 Division 3 – 10, 12, and 31 – 32. The estimated material costs shall be updated throughout construction to reflect the actual purchased material cost. The material cost for each product shall match the material cost provided on the LEED Product Data Sheet submittal. An updated schedule of values document must be submitted to the LEED Project Manager on a monthly basis.

C The General Contractor is to complete the following LEED® Action Plan submittals seven business days prior to the Preconstruction Meeting:

The LEED® Action Plan should utilize the Schedule of Values to provide preliminary estimated costs for all Divisions 3-10, 31-32 and Division 12 materials ONLY, broken out by division.

As materials are purchased, the actual materials cost (as submitted on the LEED Product Data Sheet for that product) must be recorded in the LEED Action Plan in place of the previously estimated Schedule of Values cost. This plan must be submitted to the LEED Project Manager on a monthly basis in the form of a LEED Progress Report (see item 1.5 D, item 4 below).
The construction team may also choose to predict and track the following credits on the LEED® Action Plan. The construction team will not be required to provide documentation for these credits within the LEED Action Plan. However, it is highly recommended that the team do so as it may help to determine ongoing compliance and inform which products must be purchased in order to meet the construction team’s required LEED Credit goals.

a Credit MRc4 Recycled Content, 20%: List of proposed materials with recycled content.
   1) Indicate product name and vendor, cost, percentage post-consumer recycled content, and percentage pre-consumer recycled content for each product having recycled content.

b Credit MRc5 Regional Materials, 20%: List of proposed regionally extracted, processed and manufactured materials.
   1) Identify each material and its location of manufacturer, along with the location of extraction for any material components. Identify material cost for each material.

c Credit MRc7 Certified Wood: List of proposed wood products (minimum 50% FSC Certified)
   1) Indicate each virgin wood product, its source, percentage of wood that is FSC Certified and cost.
   2) Include statement indicating total cost for wood-based materials used for Project
   3) Vendor invoices must be provided for all wood products.

D The General Contractor is to complete LEED® Progress Reports. Concurrent with each application for Payment, submit reports comparing actual construction and purchasing activities with LEED® Action Plans for the following:

1 Credit MRc2 Construction Waste Management, Divert 75% from Disposal: Waste reduction progress reports complying with Division 1 Section “Construction Waste Management.”
2 Credit EQc3.1 Construction Indoor Air Quality Management Plan: Provide a written narrative or photographs showing how the project has complied with each section of the Construction IAQ Management Plan complying with Division 1 Section “Indoor Air Quality (IAQ) Management.”
3 LEED Action Plan including updated materials cost for all materials purchased prior to the application for payment.

E The General Contractor is to provide the following completed documentation related to the following LEED® Credits or Prerequisites:
1. Prerequisite EAp3 Fundamental Refrigerant Management: Each Contractor shall provide product data for new Plumbing, HVAC, or Kitchen equipment indicating nominal tonnage and refrigerant charge, as installed, for all equipment with greater than 0.5 lbs of refrigerant.

2. Credit MRc2 Construction Waste Management: Reference Section 01 74 19 for submittal requirements.

3. Credit EQc3.1 Construction IAQ Management Plan, During Construction: Reference Section 01 57 19 for submittal requirements.

4. Per LEED® Online requirements, the contractor is responsible for initialing certain Minimum Program Requirements, Prerequisites, and Credits. The contractor is to create a LEED® Online User Account to appropriately upload initials.

F The General Contractor is to complete LEED® Product Data Sheets according to the following specifications:

1. For each product and material in Division 3 – 10, 31 – 32 and Division 12, submit fully completed LEED® Product Data Sheet including at a minimum:
   
a. Name of Product  
b. Description of Product  
c. Material Cost (no labor cost is to be included)  
d. Manufacturer  
e. Recycled Content in terms of pre-consumer (aka post-industrial) and post-consumer, as applicable.  
f. Location of Manufacturer (city, state and country)  
g. Source Location for each product component (city, state and country).  
h. Percentage of total material (determined by weight) for each product component.  
i. For each adhesive, sealant, sealant primer, paint, coating, primer, clear wood finish, stain, sealer, and shellac applied on-site, within the vapor barrier:
   1) VOC content in g/L  
   2) Category from those listed in paragraph 2.8 Low Emitting Materials – Indoor Applications  
j. Name and company of individual providing information.  
k. Trade and firm responsible for product installation or use.

2. In addition to LEED Product Data Sheets, submit formal manufacturer’s letter, Material Safety Data Sheet (MSDS), or other supporting documentation to verify the accuracy of all above noted information (items d through h). The construction team is required to submit supporting documentation for at least 25% of the materials (by cost) for each of the following Credits: MRc4 Recycled Content, MRc5 Regional Materials, MRc7 Certified Wood, EQc4.1 Adhesives and Sealants, EQc4.2 Paints and Coatings, EQc4.3 Flooring Systems, EQc4.4 Composite Wood and Agrifiber Products, EQc4.5 Systems Furniture and Seating.
The General Contractor is to provide the following Additional Submittals along with LEED Product Data Sheets.

1. For Concrete, Submit the following information for concrete-based products, for each product or concrete mix:
   a. Concrete Mix / Batch Ingredients and location of extraction / processing for each ingredient (e.g. Portland Cement, slag, fly ash, aggregate, water, etc.)
   b. Location of final ingredient assembly for each mix / batch.
   c. Mass of Portland cement per cubic yard.
   d. Mass of Recycled Supplementary Cementitious Materials (SCM) per cubic yard. SCMs include, but are not limited to, fly ash and slag.
   e. Dollar value of all cementitious materials per cubic yard.
   f. Total cubic yards used on project.

2. For Steel, Submit the following information for steel-based products:
   a. Record from Steel Supplier of Steel Manufacturers providing steel for project and, for each Steel Manufacturer, indication of:
      1) Quantity provided by each manufacturer.
      2) Recycled content percentages for each product and manufacturer.
      3) Location of manufacturing plant for each product and manufacturer.
      4) Source location of raw materials (if applicable) for each product and manufacturer.
      5) Source location of recycled content (if applicable) for each product and manufacturer.

3. For Wood, Submit the following information for wood-based products:
   a. Vendor invoice identifying each wood-based product on a line-item basis, including the following information for each product:
      1) Identification of the appropriate FSC designation, as applicable, for each item (e.g. FSC Pure, FSC Mixed Credit, FSC Mixed [NN]%, etc).
      2) FSC Chain of Custody (COC) certificate number, as applicable, for each item.
      3) Material cost for each item.
   b. Product data sheet or manufacturer’s letter indicating that the product is free of added urea-formaldehyde resins.

1.6 LEED® PROJECT MEETINGS

A. LEED® Construction Phase Kick-Off Meeting – will be held at the beginning of construction to introduce the Construction Team to the LEED® process. This meeting may be combined with a scheduled construction kickoff meeting if possible.

B. All LEED® Meetings will be combined with the regularly scheduled job meetings when possible. These meetings are to address open LEED® issues, answer questions regarding LEED® submittals or requirements, and discuss upcoming LEED® deliverables.
1.7 QUALITY ASSURANCE

A Perform Work in accordance with Green Interior Design and Construction Version 3 LEED Reference Guide, 2009 Edition (including all errata) to permit application and certification to achieve a Silver Rating under LEED® Rating System
B Perform commissioning work as specified in Section 01810 – Commissioning.
C Perform work to meet or exceed minimum energy efficiency and performance in accordance with ASHRAE 90.1 – 2007.
D Perform work without use of CFC based refrigerants in HVAC building systems.
F Develop and implement Construction Indoor Air Quality Management Plan according to Section 01352.

PART 2 – PRODUCTS

2.1 PROHIBITED MATERIALS

A Do not use CFC based refrigerants or Halon extinguishing agents.
B Do not use materials that exceed the VOC limitations in Para. 2.3.

2.2 HVAC FILTERS

A Temporary filters during construction: Minimum Efficiency Reporting Value (MERV) 8 as determined by ASHRAE 52.2 1999.
B Permanent filters before occupancy: Minimum Efficiency Reporting Value (MERV) 13 as determined by ASHRAE 52.2 1999.

2.3 LOW-EMITTING MATERIALS – INDOOR APPLICATIONS

A Credit EQc4.1 and EQc4.2: Low Emitting Materials For interior applications including MEP systems use adhesives and sealants (Reference: Section 1.5 F.1.i) that comply with the following limits for VOC content:

1 Adhesives, Sealants, and Sealant Primers: Maximum volatile organic compound content in accordance with SCAQMD Rule 1168.

   a Wood Glues: 30 g/L.
   b Metal to Metal Adhesives: 30 g/L.
   c Adhesives for Porous Materials (Except Wood): 50 g/L.
   d Subfloor Adhesives: 50 g/L.
   e Plastic Foam Adhesives: 50 g/L.
   f Carpet Adhesives: 50 g/L.
   g Carpet Pad Adhesives: 50 g/L.
   h VCT and Asphalt Tile Adhesives: 50 g/L.
   i Cove Base Adhesives: 50 g/L.
   j Gypsum Board and Panel Adhesives: 50 g/L.
k  Rubber Floor Adhesives: 60 g/L.
l  Ceramic Tile Adhesives: 65 g/L.
m  Multipurpose Construction Adhesives: 70 g/L.
n  Contact Adhesive: 80 g/L.
o  Fiberglass Adhesives: 80 g/L.
p  Structural Glazing Adhesives: 100 g/L.
q  Wood Flooring Adhesive: 100 g/L.
r  Plastic Cement Welding Compounds: 250 g/L.
s  ABS Welding Compounds: 325 g/L.
t  CPVC Welding Compounds: 490 g/L.
u  PVC Welding Compounds: 510 g/L.
v  Adhesive Primer for Plastic: 550 g/L.
w  Architectural Sealants: 250 g/L.
x  Sealant Primers for Nonporous Substrates: 250 g/L.
y  Sealant Primers for Porous Substrates: 775 g/L

2  Paints and Coatings: Maximum volatile organic compound content in accordance with GS-11.

a  Flat Paints and Coatings: VOC not more than 50 g/L.
b  Non-Flat Paints and Coatings: VOC not more than 150 g/L.
c  Anti-Corrosive Coatings: VOC not more than 250 g/L.
d  Varnishes and Sanding Sealers: VOC not more than 350 g/L.
e  Stains: VOC not more than 250 g/L.
f  Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight total aromatic compounds (hydrocarbon compounds containing one or more benzene rinse).

B  Credit EQc4.3 Low Emitting Materials Flooring Systems

1  Carpet must comply with CRI Green Label Plus Program.
2  Carpet Cushion must comply with Green Label Program.
3  Carpet Adhesives must have a VOC content of no more than 50 g/L.
4  All hard surface flooring (i.e. tile, masonry, terrazzo, and cut stone) must meet the FloorScore standard requirements
5  Concrete, wood, bamboo and cork floor finishes must meet SCAQMD Rule 1113, Architectural Coatings, effective January 1, 2004
6  Tile setting adhesives and grouts must meet SCAQMD Rule 1168 effective July 1, 2005 including the January 7, 2005 amendment.

C  Credit EQc4.4 Low Emitting Materials Composite Wood and Agrifiber Products shall contain no added urea-formaldehyde resins.

D  Credit EQc4.5 Low Emitting Materials Systems Furniture and Seating shall be Greenguard Air Quality Certified.

PART 3  – EXECUTION
3.1 Refer to Construction Waste Management Section 01351.

3.2 Refer to Construction Indoor Air Quality Management Section 01352.

END OF SECTION 01 81 13
SECTION 01 91 13 – GENERAL REQUIREMENTS – COMMISSIONING

PART 1 - GENERAL

1.1 OWNER FURNISHED

A. The commissioning authority contracted directly with the owner for this project. All documents here have been included to define contractors’ responsibilities. It is expected that each contractor participates in the commissioning process. It is the responsibility of each contractor to provide adequate personnel to do so.

1.2 RELATED DOCUMENTS

A. All drawings and general provisions of the contract, including all other Division 01 and general and supplementary conditions.

B. Section 220800 - Plumbing Commissioning

C. Section 230800 - HVAC Commissioning

D. Section 260800 – Electrical Commissioning

E. Section 260800A - Lighting and Lighting Controls Commissioning

1.3 SUMMARY

A. The purpose of the commissioning process is to provide the owner/operator of the facility with a high level of assurance that all systems and equipment have/has been installed in the prescribed manner, and operate within the performance guidelines set in the Contract Documents. The commissioning authority shall provide the owner with an unbiased, objective view of the system’s installation, operation, and performance. This process is not intended to take away or reduce the responsibility of the design team or installing contractors to provide a finished product. Commissioning is intended to enhance the quality of system start-up and aid in the orderly transfer of systems for beneficial use by the owner. The commissioning authority will be a member of the construction team, administrating and coordinating commissioning activities with the design team, construction manager, subcontractors, manufacturers and equipment suppliers.

1.4 REFERENCES

A. ASHRAE Guideline 1-1996

B. ASHRAE Guideline 0-2005

C. ACG Commissioning Guideline

D. Building Commissioning Association (BCxA)
E. USGBC LEED NC Guidebook, Energy and Atmosphere, Prerequisite 1, Fundamental Commissioning of Building Energy Systems

F. USGBC LEED NC Guidebook, Energy and Atmosphere, Credit 3, Enhanced Commissioning

1.5 SCOPE

A. The scope of services provided by the Commissioning Authority shall include, at a minimum, the following items:
   1. Review the Owner’s Project Requirement (OPR) document.
   2. Review the BOD document to ensure that it aligns with the OPR.
   3. Perform design review during Design Development (DD) phase with one back-check performed during the Construction Document (CD) phase.
   4. Review of submittal documents for commissioned systems listed in Section 1.5 (A)(9).
   5. Review the Construction Manager’s (CM) Air Quality Management Plan.
   7. Creation of the Commissioning Plan for the project.
   8. Commissioning of the following systems and equipment:
      a. HVAC Systems and Equipment and associated controls.
      b. Domestic Hot Water Systems
      c. Electrical Systems
      d. Lighting and Lighting controls
   9. May Witness and verify the system flushing and flow tests.
   10. May Witness and verify system Test and Balance (TAB).
   11. Create and provide the Systems Manual for the project.
   12. Verify training compliance.
   13. May review all warranties for the commissioned systems listed in Section 1.5 (A) (8).
   14. Perform a 10-month review of the commissioned systems listed in Section 1.5 (A) (8).

B. Information: The commissioning authority shall function as a catalyst and initiator to disseminate information and assist the design and construction teams in implementing completion of the construction process. This shall include system verification, functional performance testing, and conformance with the intended design of each system. Services include documenting construction observations, verification and functional performance testing, and documenting proper distribution of performance and operating information to the owners O&M staff.

C. Quality Assurance: Assist the responsible parties to maintain a high quality level of installation by meeting or exceeding prevailing standards and specifications.

D. Observation of Tests: The commissioning authority shall observe and coordinate testing as required to assure system performance meets the design intent.

E. Documentation of Tests: The commissioning authority shall document the results of the performance testing directly and/or assure that testing is documented by the appropriate technicians. The commissioning authority shall approve standard forms to be used by all parties for consistency of approach and type of information to be recorded.

F. Deficiencies: The commissioning authority shall provide technical expertise to oversee and verify the correction of deficiencies found during the commissioning process.
G. Resolution of Deficiencies: The commissioning authority is to remain an independent party with specific knowledge of the project. The commissioning authority shall investigate the scope and extent of the problem and facilitate communication to determine responsibilities by delineating specifications. The commissioning authority shall monitor resolution for conformance with design intent and prevailing industry standards.

H. Acceptance: The commissioning authority shall document the date of contract completion as determined by the construction manager, owner and design team. System Verification Checklists and Functional Performance Test results may be used in determining the start of the warranty period for HVAC systems and subsystems. Also reference General Conditions in Division 1.

I. O&M Material: The commissioning authority will review operating and maintenance materials for HVAC systems.

J. Phasing: The commissioning authority will review phasing plans as provided by the CM relating to temporary use of HVAC equipment, O&M considerations, warranty issues, impact of construction sequencing on occupied areas, and interruption of services from the existing equipment.

PART 2 - COMMISSIONING PLAN

2.1 COMMISSIONING PLAN DOCUMENT

A. The Commissioning Plan for this project will be maintained by the commissioning authority and will be provided to the owner upon the completion of the project as the Commissioning Final Report. This specification section as well as all commissioning-related specification sections will be included in the appendices of the Commissioning Plan. The following commissioning sections will be included in the Commissioning Plan document, at a minimum:

1. COMMISSIONING PLAN OVERVIEW
2. COMMISSIONING OBJECTIVE
3. ABBREVIATIONS AND DEFINITIONS
4. SPECIFIC ROLES AND RESPONSIBILITIES
5. COMMISSIONING PROCESS DESCRIPTION
6. PRE-DESIGN PHASE
7. DESIGN PHASE
8. CONSTRUCTION PHASE
9. OCCUPANCY AND OPERATIONS PHASE
10. SCHEDULE REQUIREMENTS
11. OWNER’S PROJECT REQUIREMENTS
12. BASIS OF DESIGN
13. PROJECT SPECIFICATIONS
14. CONTACT INFORMATION
15. COMMUNICATION FLOW
16. COMMISSIONED EQUIPMENT AND SYSTEMS
17. COMMISSIONING SCHEDULE
18. PRE-BID MEETING MINUTES
19. PRE-CONSTRUCTION COMMISSIONING MEETINGS MINUTES
20. COMMISSIONING DESIGN REVIEW
21. COMMISSIONING SUBMITTAL REVIEW
22. COMMISSIONING FINDINGS REPORTS
23. COMMISSIONING INSPECTION FORMS
24. COMMISSIONING SIGN OFF FORMS
25. OWNER TRAINING REQUIREMENTS
26. SYSTEMS MANUAL
27. COMMISSIONING MEETING MINUTES
28. GENERAL CORRESPONDENCE
29. 10 MONTH WARRANTY REVIEW

B. The Commissioning Plan is a “living” document that will be updated throughout the entire project.

2.2 COMMISSIONING TEAM

A. The Commissioning Team (CT) shall consist of key parties involved in design, construction and testing of this facility. It is necessary for each agency to appoint team members that will have long-term commitments to this project. Switching team members during the project will reduce the ability of the CT to provide continuity and acceptable results to the building owner. Team members must maintain an ongoing supervisory position on this project. One team member shall be provided by each of the parties listed below:
1. Construction Manager
2. HVAC Contractor and each of the following subcontractors:
   a. Testing and Balancing
   b. Controls
3. Architectural/Engineering firm(s)
4. Plumbing Contractor
5. Electrical Contractor
   a. Lighting Controls Installer

2.3 CONTRACT DOCUMENT

A. The Contract Document includes design drawings, construction specifications, submittals, change orders and industry standards that describe the HVAC systems of this facility. References to design intent will be taken from these contract documents. Any industry standards used for this project will be specifically noted when referenced.

B. The CxA will review the contract documents for adequate commissioning provisions, functional performance, accessibility, TAB provisions, O&M considerations, and optimization of performance.

2.4 COMMISSIONING MEETINGS

A. The CxA will arrange, through the CM, specific commissioning meetings as necessary to resolve any commissioning finding questions or concerns. The CxA will be on site for the Commissioning meetings. Commissioning meetings will be used to address any problems that alter the design intent or affect the commissioning process. The CxA will not attend regularly scheduled construction meetings. The CxA will regularly review all meeting minutes and construction schedules and use those tools to stay apprised of all project milestones.
2.5 BUILDING TURN-OVER / OWNER ORIENTATION / USER TRAINING

A. Owner training will be provided by the installing contractor, or manufacturer’s representative, and may be witnessed by the Commissioning Authority. This training should include both classroom training and hands-on operational training. The owner may choose to videotape this training for future use. The Commissioning Authority may visit the site during the Turn-Over and Training period to assure that any on-going HVAC related problems are being addressed and corrected in a timely and efficient manner.

B. The Commissioning Authority will assist in the coordination of off-season testing, calibrating, and servicing as specified in the contract documents.

2.6 WARRANTY REVIEW

A. The commissioning authority will participate in a 10-month walk-through to observe the operation of all commissioned systems and/or equipment. This will include a review meeting with the owner and Construction Manager, a discussion of warranty issues, energy usage, maintenance practices, usage changes, and chronic problems, as well as other issues affecting the owner and the operation of all commissioned systems.

END OF SECTION 01 9113
SECTION 024119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Demolition and removal of selected site elements.
   2. Salvage of existing items to be reused or recycled.

1.2 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.

1.4 INFORMATIONAL SUBMITTALS

A. Predemolition Photographs or Video: Submit before Work begins.

1.5 CLOSEOUT SUBMITTALS

A. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.6 FIELD CONDITIONS

A. Owner will occupy portions of site immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   1. Hazardous materials will be removed by Owner before start of the Work.
   2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner.
   3. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
   1. Maintain fire-protection facilities in service during selective demolition operations.

1.7 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
C. When unanticipated elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

D. Survey of Existing Conditions: Record existing conditions by use of measured drawings, preconstruction photographs and preconstruction videotapes.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor if necessary.
2. Arrange to shut off indicated utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of site.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and
chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.

2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

3. Do not use cutting torches until work area is cleared of flammable materials.

4. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on site improvements.

5. Dispose of demolished items and materials promptly.

B. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area on-site as designated by Owner.
5. Protect items from damage during transport and storage.

C. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition, cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.5 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.
3.6 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024119
SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:

1. Section 033300 "Architectural Concrete" for general building applications of specially finished formed concrete.
2. Section 312000 "Earth Moving" for drainage fill under slabs-on-grade.
3. Section 321313 "Concrete Paving" for concrete pavement and walks.
4. Section 321316 "Decorative Concrete Paving" for decorative concrete pavement and walks.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
D. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1. Location of construction joints is subject to approval of the Architect.

E. Samples: For waterstops and vapor retarder.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Welding certificates.

C. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Waterstops.
6. Curing compounds.
7. Floor and slab treatments.
10. Vapor retarders.
11. Semirigid joint filler.

D. Material Test Reports: For the following, from a qualified testing agency:

1. Aggregates.

E. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.

1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

F. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

G. Field quality-control reports.
1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Testing Agency Qualifications: An independent agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

1.8 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301 (ACI 301M).
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
B. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and as follows:

1. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301 (ACI 301M).
2. ACI 117 (ACI 117M).

2.2 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.

E. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

F. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.


G. Form Ties: Factory-fabricated, removable or snap-off glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish units that leave no corrodible metal closer than 1 inch (25 mm) to the plane of exposed concrete surface.
2. Furnish ties that, when removed, leave holes no larger than 1 inch (25 mm) in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
C. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60 (Grade 420)] deformed bars, assembled with clips.
D. Plain-Steel Wire: ASTM A 1064/A 1064M, as drawn.
E. Deformed-Steel Wire: ASTM A 1064/A 1064M.
F. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.

2.4 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars, cut true to length with ends square and free of burrs.
B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

2.5 CONCRETE MATERIALS

A. Cementitious Materials:

1. Portland Cement: ASTM C 150/C 150M, Type I/II
2. Fly Ash: ASTM C 618, Class F or C.
3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33/C 33M aggregate or better, graded and as follow:
1. Class: ASTM C33 5S or better, Severe weathering region for foundations and foundation walls. For exterior slabs and pavement: ASTM C33-5S, Number 57 (1-inch) crushed limestone, or other aggregate which has been demonstrated to produce durable exterior concrete free of pop outs and spalling. Class 3M can be used for interior slab-on-grade and elevated for slabs.

2. Maximum Coarse-Aggregate Size: 1 inch (25 mm) nominal.


C. Air-Entraining Admixture: ASTM C 260/C 260M.

D. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

E. Water: ASTM C 94/C 94M and potable.

2.6 WATERSTOPS

A. Flexible PVC Waterstops: CE CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. GreenStreak: Type 757; Sika Corporation
2. Profile: Flat dumbbell with center bulb
3. Dimensions: 6 inches by 1/4 inch thick (225 mm by 10 mm thick); nontapered.

2.7 VAPOR RETARDERS

A. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 15 mils thick.

2.8 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Spray-Film; ChemMasters.
2. Sure Film; Dayton Superior Corporation.
3. Euclid Chemical Co.
4. Vapor Aid; Kaufman Products, Inc.
5. Lambco Skin; Lambert Corporation.
7. Waterhold; Metalcrete Industries.
8. SikaFilm; Sika Corporation.
9. Certi-Vex EnvioAssist; Vexcon Chemicals, Inc.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable

E. Liquid Curing Compounds:
   1. Curing compounds shall comply with ASTM C309.
   2. Provide products which are compatible with floor coatings or toppings specified.
   3. Manufacturer shall guarantee that Manufacturer's material is compatible with the intended application.
   4. No wax based compounds allowed.
   5. No acrylics allowed where toppings or coatings are to be applied.
   6. Compounds:
      a. Curing:
      1) 1100 Clear by W.R. Meadows.
      2) Rez Cure (J-11-W) by Dayton Superior.
      3) Masterkure by Master Builders.
      4) L & M Cure by L & M Chemical.
      5) Or equal.
      b. Curing and Hardening:
      2) Sil-Cure (J-13) by Dayton Superior.
      3) L & M Chem Hard by L & M Chemical.
      4) Or equal.

F. Hardened Concrete Topping:
   1. Heavy duty emery mineral topping premixed.
   2. Dayton Superior Corporation, Emery Tuff Top, L&M Construction chemicals, Inc. or equal.

G. Sealer: Vocomp-25 by W.R. Meadows (water based acrylic); or equal.

2.9 RELATED MATERIALS

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, aromatic polyurea with a Type A shore durometer hardness range of 90 to 95 according to ASTM D 2240.

C. Bonding Agent: ASTM C 1059/C 1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
   1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

E. Reglets: Fabricate reglets of not less than 0.022-inch- (0.55-mm-) thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

F. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch (0.85 mm) thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.10 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.
   2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
   3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by underlayment manufacturer.
   4. Compressive Strength: Not less than [4100 psi (29 MPa)] <Insert strength> at 28 days when tested according to ASTM C 109/C 109M.

2.11 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301 (ACI 301M).
   1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
   1. Fly Ash: 25 percent.
4. Combined Fly Ash or Pozzolan and Slag Cement: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
5. Silica Fume: 10 percent.
6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
7. Combined Fly Ash or Pozzolans, Slag Cement, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
8. For concrete exposed to deicers, limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements.

C. Limit water-soluble, chloride-ion content in hardened concrete 0.15 percent by weight of cement. For Mix Type C (Tank Enclosure Walls including Foundation Mat) limit water-soluble chloride-ion content to 0.08 percent.

D. Admixtures: Use admixtures according to manufacturer's written instructions.
   1. Use high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
   2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
   3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a w/c ratio below 0.50.

2.12 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Footings: Normal-weight concrete.
   1. Minimum Compressive Strength: 3000 psi (20.7 MPa) at 28 days.
   2. Maximum W/C Ratio: 0.45.
   3. Slump Limit: 4 inches (100 mm); 7 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture plus or minus 1 inch (25 mm).
   4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) nominal maximum aggregate size.

   1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
   2. Maximum W/C Ratio: 0.45.
   3. Slump Limit: 4 inches (100 mm); 7 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch (25 mm).

C. Slabs-on-Grade and Exterior Equipment Pads: Normal-weight concrete.
   1. Minimum Compressive Strength: 4500 psi (31 MPa) at 28 days.
   2. Maximum W/C Ratio: 0.45
3. Minimum Cementitious Materials Content: 520 lb/cu. yd. (309 kg/cu. m)
4. Slump Limit: 5 inches (125 mm), plus or minus 1 inch (25 mm).
5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch (19-mm) nominal maximum aggregate size.
   Do not allow air content of trowel-finished floors to exceed 3 percent.

D. Elevated Slabs: Normal-weight concrete.
   1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
   2. Maximum W/C Ratio: 0.45
   3. Minimum Cementitious Materials Content: 470 lb/cu. yd. (279 kg/cu. m)
   4. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm).
   5. Air Content: Do not air entrain concrete to trowel-finished interior elevated slabs. Do not allow entrapped air content to exceed 3 percent. Insert w/c ratio here if elevated slabs are subject to special exposure conditions.

2.13 FABRICATING REINFORCEMENT
   A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.14 CONCRETE MIXING
   A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
      1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION
   A. Design, erect, shore, brace, and maintain formwork, according to ACI 301 (ACI 301M), to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
   B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 (ACI 117M).
   C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
      1. Class A, 1/8 inch (3.2 mm)] for smooth-formed finished surfaces.
      2. Class D, 1 inch (25 mm) for rough-formed finished surfaces.
   D. Construct forms tight enough to prevent loss of concrete mortar.
E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEM INSTALLATION

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
3. Install dovetail anchor slots in concrete structures as indicated.

3.3 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete. Concrete has to be hard enough to not be
damaged by form-removal operations, and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved its 28-day design compressive strength.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material are not acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 SHORING AND RESHORING INSTALLATION

A. Comply with ACI 318 (ACI 318M) and ACI 301 (ACI 301M) for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

3.5 VAPOR-RETARDER INSTALLATION

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended tape.

3.6 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
E. Install welded-wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

F. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.

G. Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material according to ASTM A 780/A 780M. Use galvanized-steel wire ties to fasten zinc-coated steel reinforcement.

3.7 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
2. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.8 WATERSTOP INSTALLATION

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

3.9 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301 (ACI 301M).

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301 (ACI 301M).
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

3.10 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete.

C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.11 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces indicated.

C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of
trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
2. Finish surfaces to the following tolerances, according to ASTM E 1155 (ASTM E 1155M), for a randomly trafficked floor surface:
   a. Specified overall values of flatness, F(F) 50; and of levelness, F(L) 35; with minimum local values of flatness, F(F) 35; and of levelness, F(L) 25; for slabs-on-grade.
   b. Specified overall values of flatness, F(F) 30; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 15; for elevated slabs.
3. Finish and measure surface, so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- (3.05-m-) long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch (3.2 mm).
4. Slab sections as defined by construction joints not meeting the tolerance criteria shall be removed. At the Owner’s option, non-conforming joints in areas with finish flooring may be ground till conforming.

D. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset method. While concrete is still plastic, slightly scarify surface with a fine broom.
   1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
   1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

F. Floor Sealer:
   1. Apply 2 Epoxy Coating to Open Hangar floor areas (non-enclosed by wall construction) in accordance with the Manufacturer’s recommendations
   2. Ensure that surface preparation and cleanliness requirements are adhered to for both coats.

3.12 MISCELLANEOUS CONCRETE ITEM INSTALLATION

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:
   1. Coordinate sizes and locations of concrete bases with actual equipment provided.
   2. Construct concrete bases 4 inches (100 mm) high unless otherwise indicated, and extend base not less than 6 inches (150 mm) in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
   3. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
   4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
   6. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   7. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

3.13 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 (ACI 301M) for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
   1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
a. Water.
b. Continuous water-fog spray.
c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers. Do not use polyethylene sheets on exposed interior floors.

2. **Moisture-Retaining-Cover Curing:** Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.

   a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
   b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
   c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies does not interfere with bonding of floor covering used on Project.

3. **Curing Compound:** Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

   a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer[ unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project].

4. **Curing and Sealing Compound:** Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.14 **LIQUID FLOOR TREATMENT APPLICATION**

A. **Penetrating Liquid Floor Treatment:** Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.

   1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
   2. Do not apply to concrete that is less than 14 days' old.
   3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.
B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.15 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least six months. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.16 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension to solid concrete. Limit cut depth to 3/4 inch (19 mm). Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar matches surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.

2. After concrete has cured at least 14 days, correct high areas by grinding.

3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.

4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.

5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

6. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch (19-mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

7. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

G. Repair tank enclosure wall tie holes and defects according to manufacturer’s recommendations with one of the following preapproved patch materials:

1. Manufacturers:
   a. Krystol Bari-Cote by Kryton.
   b. Patch ‘N Plug by Xypex.
   c. Penecrete Mortar by Penetron.
   d. Aquafin Plug IC by Aquafin.
3.17 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified testing and inspecting agency to perform field tests and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and submit reports.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mixture placed each day.
   a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM  C 231/C 231M, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below or 80 deg F (27 deg C) and above, and one test for each composite sample.

5. Compression Test Specimens: ASTM C 31/C 31M.
   a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.

6. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
   a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
   b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).

9. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete mixture, and test results.
testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.

12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

D. Measure floor and slab flatness and levelness according to ASTM E 1155 (ASTM E 1155M) within 72 hours of finishing.

3.18 PROTECTION OF LIQUID FLOOR TREATMENTS

A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 03 30 00
SECTION 040120 - MAINTENANCE OF UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes maintenance of unit masonry consisting of brick clay masonry restoration and cleaning as follows:

1. Repairing unit masonry, including replacing units.
2. Repointing joints.
3. Preliminary cleaning, including removing plant growth.
4. Cleaning exposed unit masonry surfaces.
   a. For exposed existing interior masonry scheduled to remain unfinished.
   b. For existing masonry scheduled to be painted, see Exterior Painting for additional prep required for painting of unit masonry.

1.2 DEFINITIONS

A. Low-Pressure Spray: 100 to 400 psi (690 to 2750 kPa); 4 to 6 gpm (0.25 to 0.4 L/s).

B. Medium-Pressure Spray: 400 to 800 psi (2750 to 5510 kPa); 4 to 6 gpm (0.25 to 0.4 L/s).

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For the following:
   1. Provisions for expansion joints or other sealant joints.

C. Samples: For each exposed product and for each color and texture specified.

1.4 QUALITY ASSURANCE

A. Restoration Specialist Qualifications: Engage an experienced masonry restoration and cleaning firm to perform work of this Section. Firm shall have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience installing standard unit masonry is not sufficient experience for masonry restoration work.

   1. At Contractor's option, work may be divided between two specialist firms: one for cleaning work and one for repair work.
2. Field Supervision: Restoration specialist firms shall maintain experienced full-time supervisors on Project site during times that clay masonry restoration and cleaning work is in progress.

3. Restoration Worker Qualifications: Persons who are experienced in restoration work of types they will be performing.

B. Pre-installation Conference: Conduct conference at Project site.

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**PART 2 - PRODUCTS**

### 2.1 MORTAR MATERIALS

A. Portland Cement: ASTM C 150, Type I or Type II, white or gray or both where required for color matching of exposed mortar.
   
   1. Provide cement containing not more than 0.60 percent total alkali when tested according to ASTM C 114.

B. Hydrated Lime: ASTM C 207, Type S.

C. Mortar Sand: ASTM C 144 unless otherwise indicated.
   
   1. Color: Provide natural sand or ground marble, granite, or other sound stone of color necessary to produce required mortar color.
   2. For pointing mortar, provide sand with rounded edges.
   3. Match size, texture, and gradation of existing mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match.

D. Mortar Pigments: Natural and synthetic iron oxides, compounded for mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortars. Color of mortar shall match existing mortar color (integral pigment if required)

E. Mortar color shall match the color of the existing mortar at adjacent areas.

F. Water: Potable.

### 2.2 CLEANING MATERIALS

A. Water: Potable.

B. Hot Water: Water heated to a temperature of 140 to 160 deg F (60 to 71 deg C).

C. Acidic Cleaner: Manufacturer's standard acidic masonry cleaner composed of hydrofluoric acid or ammonium bifluoride blended with other acids, detergents, wetting agents, and inhibitors.

   1. Products: Subject to compliance with requirements, provide one of the following:
a. ABR Products, Inc.
b. Diedrich Technologies Inc.
c. Dumond Chemicals, Inc.
d. EaCo Chem, Inc.
e. Hydroclean, Hydrochemical Techniques, Inc.
f. Price Research, Ltd.
g. PROSOCO.

2.3 CHEMICAL CLEANING SOLUTIONS

A. Dilute chemical cleaners with water to produce solutions not exceeding concentration recommended by chemical-cleaner manufacturer.

B. Acidic Cleaner Solution for Brick: Dilute with water to produce hydrofluoric acid content of 3 percent or less, but not greater than that recommended by chemical-cleaner manufacturer.

PART 3 - EXECUTION

3.1 PROTECTION

A. Protect persons, motor vehicles, surrounding surfaces of building being restored, building site, plants, and surrounding buildings from harm resulting from masonry restoration work.

B. Comply with chemical-cleaner manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent chemical-cleaning solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

1. Cover adjacent surfaces with materials that are proven to resist chemical cleaners used unless chemical cleaners being used will not damage adjacent surfaces. Use materials that contain only waterproof, UV-resistant adhesives. Apply masking agents to comply with manufacturer's written instructions. When no longer needed, promptly remove masking to prevent adhesive staining.

2. Keep wall wet below area being cleaned to prevent streaking from runoff.

3.2 CLEANING MASONRY, GENERAL

A. All existing exterior masonry to remain is to be cleaned.

A. Proceed with cleaning in an orderly manner; work from [bottom to top] [top to bottom] of each scaffold width and from one end of each elevation to the other. Ensure that dirty residues and rinse water will not wash over cleaned, dry surfaces.

B. Use only those cleaning methods indicated for each masonry material and location.
1. Do not use wire brushes or brushes that are not resistant to chemical cleaner being used. Do not use plastic-bristle brushes if natural-fiber brushes will resist chemical cleaner being used.

2. Use spray equipment that provides controlled application at volume and pressure indicated, measured at spray tip. Adjust pressure and volume to ensure that cleaning methods do not damage masonry.
   a. Equip units with pressure gages.

3. For chemical-cleaner spray application, use low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with cone-shaped spray tip.

4. For water-spray application, use fan-shaped spray tip that disperses water at an angle of 25 to 50 degrees.

5. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F (60 and 71 deg C) at flow rates indicated.

C. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging masonry surfaces.

D. Water-Spray Application Method: Unless otherwise indicated, hold spray nozzle at least 6 inches (150 mm) from surface of masonry and apply water in horizontal back and forth sweeping motion, overlapping previous strokes to produce uniform coverage.

E. Chemical-Cleaner Application Methods: Apply chemical cleaners to masonry surfaces to comply with chemical-cleaner manufacturer's written instructions; use brush[or spray] application.[Do not spray apply at pressures exceeding 50 psi (345 kPa).] Do not allow chemicals to remain on surface for periods longer than those indicated or recommended by manufacturer.

F. Rinse off chemical residue and soil by working upward from bottom to top of each treated area at each stage or scaffold setting. Periodically during each rinse, test pH of rinse water running off of cleaned area to determine that chemical cleaner is completely removed.
   1. Apply neutralizing agent and repeat rinse if necessary to produce tested pH of between 6.7 and 7.5.

3.3 PRELIMINARY CLEANING

A. Removing Plant Growth: Completely remove visible plant, moss, and shrub growth from masonry surfaces. Carefully remove plants, creepers, and vegetation by cutting at roots and allowing to dry as long as possible before removal. Remove loose soil and debris from open masonry joints to whatever depth they occur.

B. Preliminary Cleaning: Before beginning general cleaning, remove extraneous substances that are resistant to cleaning methods being used. Extraneous substances include paint, calking, asphalt, and tar.
1. Carefully remove heavy accumulations of material from surface of masonry with a sharp chisel. Do not scratch or chip masonry surface.
2. Remove paint and calking with alkaline paint remover.
   b. Repeat application up to two times if needed.
3. Remove asphalt and tar with solvent-type paint remover.
   b. Apply paint remover only to asphalt and tar by brush without prewetting.
   c. Allow paint remover to remain on surface for 10 to 30 minutes.
   d. Repeat application if needed.

3.4 CLEANING MASONRY

A. Acidic Chemical Cleaning:
   1. Wet masonry with cold water applied by low-pressure spray.
   2. Apply cleaner to masonry in two applications by brush or low-pressure spray. Let cleaner remain on surface for period indicated below:
      a. As recommended by chemical-cleaner manufacturer.
   3. Rinse with cold water applied by low-pressure spray to remove chemicals and soil.

END OF SECTION 040120
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes unit masonry assemblies consisting of the following:
   1. Face brick.
   2. Mortar and grout.
   3. Reinforcing steel.
   4. Masonry joint reinforcement.
   5. Ties and anchors.
   6. Embedded flashing.
      a. Reglet
   7. Miscellaneous masonry accessories.
   8. Cavity-wall insulation.

B. Products installed, but not furnished, under this Section include the following:
   1. Steel lintels and shelf angles for unit masonry, furnished under Division 05 Section
      “Structural Steel Framing”.

1.2 RELATED SECTIONS

1. Section 018113 – Sustainability Requirements

1.3 DEFINITIONS

A. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells or cavities.

B. Cavity Mortar Protection: Used in conjunction with flashing and weep vents to provide a
   system to properly evacuate moisture from a masonry cavity wall by providing a continuous
   path for incidental moisture to escape from weep vents.

1.4 PERFORMANCE REQUIREMENTS

A. Provide unit masonry that develops indicated net-area compressive strengths ($f_m'$) at 28 days.

B. Determine net-area compressive strength ($f_m'$) of masonry from average net-area compressive
   strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2
   in ACI 530.1/ASCE 6/TMS 602.

C. Regulatory Requirements: Comply with the provisions of the following codes, specifications,
   and standards, except as otherwise shown or specified:
   1. ACI 530-ASCE 5 Building Code Requirements For Masonry Structures.
   2. ACI 530.1/ASCE 6 Specifications for Masonry Structures.
      a. Maintain one copy of the standard in project field office at all times during
         construction. Contractor’s supervisory personnel shall be thoroughly familiar with
         this material as it applies to the project.
   3. National Concrete Masonry Association (NCMA)
      a. NCMA TEK Bulletin 3-1A “Cold Weather Concrete Masonry Construction”.
b. NCMA TEK Bulletin 3-1C “All Weather Concrete Masonry Construction”.

c. NCMA TEK Bulletin 3-2 “Grouting for Concrete Masonry Walls”.

d. NCMA TEK Bulletin 3-3A “Reinforced Concrete Masonry”.

e. NCMA TEK Bulletin 3-4B “Bracing Concrete Masonry Walls During Construction”.

f. NCMA TEK Bulletin 5-2A “Clay and Concrete Masonry Banding Details”.

g. NCMA TEK Bulletin 7-1A “Fire Resistance Rating of Concrete Masonry Assemblies”.

h. NCMA TEK Bulletin 8-2A “Removal of Stains from Concrete Masonry.”

i. NCMA TEK Bulletin 8-3A “Control and Removal of Efflorescence.”

j. NCMA TEK Bulletin 9-1 “Mortars for Concrete Masonry.”

k. NCMA TEK Bulletin 10-1A “Crack Control in Concrete Masonry Walls – Empirical Method”.

l. NCMA TEK Bulletin 10-2B “Control Joints for Concrete Masonry Walls”.

m. NCMA TEK Bulletin 10-4 “Crack Control for Concrete Brick and Other Concrete Masonry Veneers”.

n. NCMA TEK Bulletin 12-4C “Steel Reinforcement for Concrete Masonry”.

o. NCMA TEK Bulletin 14-2 “Reinforced Concrete Masonry”.

p. NCMA TEK Bulletin 19-4 “Flashing Concrete Masonry”.

q. NCMA TEK Bulletin 19-4A “Flashing Strategies for Concrete Masonry Walls”.

r. NCMA TEK Bulletin 19-5 “Use of Flashing in Concrete Masonry Walls”.


a. ASTM C33-97 “Concrete Aggregates”.

b. ASTM C90-97a “Loadbearing Concrete Masonry Units”.

c. ASTM C91 “Masonry Cement”.

d. ASTM C140-75 (R-1988) “Standard Methods of Sampling and Testing Concrete Masonry Units”.

e. ASTM C144 “Aggregate for Masonry Mortar”.

f. ASTM C150 “Portland Cement”.

g. ASTM C207 “Hydrated Lime for Masonry Purposes”.

h. ASTM C270 “Mortar of Unit Masonry”.

i. ASTM C426-96a “Testing for Drying Shrinkage of Concrete Block”.

j. ASTM C780 “Preconstruction and Construction Evaluation of Mortars Plain and Reinforced Unit Masonry”.

k. ASTM C979 “Pigments for Integrally Colored Concrete”.

l. ASTM E514 “Water Penetration and Leakage Through Masonry”.

5. International Masonry Industry All-Weather Council (IMIAWC).


6. Underwriters’ Laboratory Inc. (UL)

a. UL “Building Materials Directory”.

b. UL 618 “Standard for Concrete Masonry”.

7. Brick Institute of America (BIA)


c. BIA Technical Notes No. 7 – Water Penetration Resistance – Design and Detail.

d. BIA Technical Notes No. 20 – Revised 1990: Cleaning Brick Masonry.

e. BIA Technical Notes No. 28B – Revised 1987: Brick Veneer.
1.5 SUBMITTALS

A. Shop Drawings: For the following:
   1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
   2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.

B. Samples for Initial Selection: For the following:
   1. Decorative concrete masonry units, in the form of small-scale units.
   2. Face brick, in the form of straps of five or more bricks.
   3. Weep holes/vents.

C. Samples for Verification: For each type and color of the following:
   1. Decorative concrete masonry units.
   2. Weep holes/vents.
   3. Accessories embedded in masonry.

D. Quality Assurance/Control Submittals:
   1. Product Data: For each type of product indicated, including but not limited to:
      a. Cavity wall insulation.
      b. Integral water repellent.
   2. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
      a. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing. See drawings for mockup panel details.
   3. Qualification Data: For testing agency.
   4. Material Certificates: Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards. Provide for each type and size of the following:
      a. Masonry units.
         1) Provide material test reports substantiating compliance with requirements, if requested.
         2) For bricks, include size-variation data verifying that actual range of sizes falls within specified tolerances.
         3) For exposed brick, include material test report for efflorescence according to ASTM C 67.
         4) For surface-coated brick, include material test report for durability of surface appearance after 50-cycles of freezing and thawing per ASTM C 67.
      b. CMU: Upon regular presentation within past 12 months of representative units by approved manufacturer, a test report from an independent laboratory showing resultant weight, compressive strength (based on net area), and water absorption properties, as well as adherence to standards where so specified, for:
         1) Each proposed type and size of concrete masonry units.
         2) Test reports shall conform to ASTM C140 and shall include:
            a) Name of Manufacturer
b) Date of Manufacture of Test Specimen  
c) Dimension Measurements (in.)  
d) Calculated Gross Area (sq.in.)  
e) Calculated Net Area (sq.in.)  
f) Total Load (lbs.)  
g) Net Unit Load (psi)  
h) Sample Weight (lbs.)  
i) Dry Weight (lbs.)  
j) Wet Weight (lbs.)  
k) Immersed Weight (lbs.)  
l) Density (pcf)  
m) Moisture Content (%)  
n) Absorption (%)  
o) Linear Shrinkage Coefficient (%)  

Cementitious materials. Include brand, type, and name of manufacturer.  
Preblended, dry mortar mixes. Include description of type and proportions of ingredients.  
Grout mixes. Include description of type and proportions of ingredients.  
Reinforcing bars.  
Joint reinforcement.  
 Anchors, ties, and metal accessories.  
Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.  
Include test reports, per ASTM C 780, for mortar mixes required to comply with property specification.  
Include test reports, per ASTM C 1019, for grout mixes required to comply with compressive strength requirement. For both fine and course grouts including complete identities and proportions of ingredients.  
1) Weight of each ingredient including water.  
2) Measured slump.  
3) Water/cement ratio.  
4) Sieve analysis for aggregates.  

Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.  
Certification: Firm shall have at least five years experience in placing reinforced masonry wall systems and will assign supervision of installation only to personnel able to show evidence of current, “Grouting and Reinforcing Certification” by the International Masonry Institute as a “Certified Grout Installer” or having successfully completed the IMI training and certification for “Grouting and Reinforcing Certification.”  
The “certified” supervisor responsible for the placement of reinforced assemblies, will be present at the grout pour location at the time of each grout pour.  
Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.  

LEED Submittals  
Credit MR4; Recycled Content: Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.  
Include statement indicating costs for each product having recycled content.
2. Credit MR5; Local/Regional Materials
   a. Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
   b. Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1093 for testing indicated, as documented according to ASTM E 548.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate. Do not change source or brands of masonry mortar materials during the course of the Work.

D. Preconstruction Testing Service: Contractor will engage a qualified independent testing agency to perform preconstruction testing indicated below.
   1. Clay Masonry Unit Test: For each type of unit required, per ASTM C 67.
   2. Concrete Masonry Unit Test: For each type of unit required, per ASTM C 140.
   3. Grout Test (Compressive Strength): For each mix required, per ASTM C 1019.

E. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects. Comply with requirements in Division 01 Section "Quality Requirements" for mockups.
   1. Build 4'-0" x 4'-0" sample panels verify location with accuracy.
   2. Clean exposed faces of panels with masonry cleaner indicated.
   3. Protect approved sample panels from the elements with weather-resistant membrane.
   4. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.
      a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless such deviations are specifically approved by Architect in writing.
   5. Prior to starting general masonry cleaning, prepare mock-up for cleaning using the same cleaning materials and methods proposed for the Work, and under same weather conditions to be expected during cleaning. Obtain A/E's acceptance of visual qualities before proceeding with masonry restoration. Record cleaning process and results of all testing.
      a. Test materials and methods on samples of adjacent nonmasonry materials for possible reaction with cleaning materials, except where materials and methods are known to have a deleterious effect on such materials.
      b. Allow a waiting period of the duration indicated, but not less than 7 calendar days, after completion of sample cleaning to permit a study of sample panels for negative reactions.
6. Protect accepted mockups from the elements with weather-resistant membrane.
7. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
   a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
   b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.
8. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Assume responsibility for acceptance of masonry units delivered to site being in compliance with specified ASTM requirements for chippage and dimensional tolerances.

B. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

D. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
   1. Stock pile and handle aggregates to prevent contamination from foreign materials. Store different aggregates separately.

E. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.

F. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.8 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
   1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
   2. Where 1 wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.
   3. Rotate and flip scaffolding boards each day to prevent mortar staining.
B. This structure is designed to be self-supporting and stable after the building is fully completed. Protect masonry walls against wind damage by bracing as required until support of walls is integral with the completed building structure. This includes the addition of whatever temporary bracing, guys, or tie-downs that might be necessary. Such material is not shown on the Drawings. If applied, they shall be removed as conditions permit, and shall remain the Contractor’s property.
1. Safety: It is solely the Contractor’s responsibility to follow all applicable safety codes and regulations governing this Work.
2. Load application after building masonry columns, piers, or walls
   a. Do not apply uniform design floor or roof loading for at least 12 hours.
   b. Do not apply concentrated loads for at least 3 days.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602 with special emphasis on the following:
1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.
   a. To assure mortar temperatures between 40 degrees F and 120 degrees F until used, heat mixing water or aggregates when air temperature is between 32 degrees F and 40 degrees F. When the air temperature is between 25 degrees F and 32 degrees F, heat both water and aggregate.
   b. Do not heat water or sand above 160 degrees F.
2. Comply with the requirements of the governing code and with the "Construction and Protection Recommendations for Cold Weather Masonry Construction" of the Technical Notes of Brick and Tile Construction by the Brick Institute of America (BIA) and International Masonry Industry All-Weather Council, “Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.”

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602 and the following:
1. Masonry construction performed when ambient temperature exceeds 100 degrees F (or 90 degrees F with wind velocities greater than 8 mph) shall conform to the following requirements:
   a. Store materials in cool, shaded location.
   b. Cover aggregate stockpiles with black plastic sheet to retard the evaporation of moisture.
c. Cool reinforcing steel, metal accessories, wheelbarrows, mixers and mortar boards by flushing with water.

d. Wet high-suction brick.

e. Increase lime and/or cement content to maximum allowed under ASTM C270 for mortar type specified.

f. Increase water content of mortar and grout as needed.

g. Spread mortar beds no more than 4 feet ahead of masonry, and set units within one minute of spreading mortar.

h. Moist cure masonry by water fog spray after tooled joints have set.

i. Cover walls to retard evaporation.

j. Schedule work to avoid hottest part of day.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Products: Subject to compliance with requirements, provide one of the products specified.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

B. Products of other manufacturers will be considered for acceptance provided they equal or exceed the material requirements and functional qualities of the specified product. The “Substitution Request Form” and complete technical data for evaluation must accompany request for A/E’s approval. All materials for evaluation must be received by the Construction Manager at least 10 days prior to bid due date. Additional approved manufacturers will be issued by Addendum.

2.2 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to exceed tolerances and to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects, including dimensions that vary from specified dimensions by more than stated tolerances, will be exposed in the completed Work or will impair the quality of completed masonry.

2.3 BRICK

A. General: Provide shapes indicated and as follows:

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.

2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.

3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.

4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
B. Face Brick: ASTM C 216, Grade SW, Type FBS.
   1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 8250 psi.
   2. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
   3. Manufacturers:
      a. Refer to basis of design below. Alternate manufacturers allowable pending color and blend approval. Intent is that the brick match as closely to basis of design as possible in module, color, texture.
         a) Basis of Design - Belden
         b) Hansen
         c) GlenGery
         d) Redland
         e) Statesville
   4. Size, color, and Texture:
      1) Brick Type 2 – Utility Size, Basis of Design Belden, Color and texture to be selected by Architect
      2) Brick Type 3 – Utility Size, Basis of Design Belden, Color and texture to be selected by Architect

2.4 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or Type III which may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S.

D. Masonry Cement: ASTM C 91, to be used at masonry veneer only.
   1. Products:
      a. Essroc, Italcementi Group; Brixment or Velvet.
      b. Holcim (US) Inc.; Mortamix Masonry Cement or Rainbow Mortamix Custom Buff Masonry Cement or White Mortamix Masonry Cement.
      c. Lafarge North America Inc.; Magnolia Masonry Cement or Lafarge Masonry Cement or Trinity White Masonry Type S or Trinity White Masonry Type N.
      d. Lehigh Cement Company; Lehigh Masonry Cement or Lehigh White Masonry Cement.
      f. CEMEX; Richcolor and Richmortar.

E. Mortar Cement: ASTM C 1329.

F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.
   1. Products:
      b. Davis Colors; True Tone Mortar Colors.
c. Solomon Grind-Chem Services, Inc.; SGS Mortar Colors.

G. Colored Cement Product: Packaged blend made from Portland cement and lime, masonry cement, or mortar cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.
   1. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
   2. Pigments shall not exceed 10 percent of Portland cement by weight.
   3. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
   4. Products:
      a. Colored Portland Cement-Lime Mix:
         2) Holcim (US) Inc.; Rainbow Mortamix Custom Color Cement/Lime.
         3) Lafarge North America Inc.; Eaglebond.
         4) Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.
         5) Glen-Gery Corp., Color Mortar Blend
         6) Essroc; Salyor’s PLUS
         7) CEMEX; PCL
         8) Lone Star; Portland Lime Mortar Cement.
      b. Colored Masonry Cement:
         1) Capital Materials Corporation; Flamingo Color Masonry Cement.
         2) Essroc, Italcementi Group; Brixment-in-Color.
         3) Holcim (US) Inc.; Rainbow Mortamix Custom Color Masonry Cement.
         4) Lafarge North America Inc.; Magnolia Masonry Cement.
         5) Lehigh Cement Company; Lehigh Custom Color Masonry Cement.
         7) CEMEX; Richcolor Masonry Cement.

H. It is anticipated that all mortar will be colored. The mortar color shall be selected from full range of colors. Submit samples for final approval.

I. Aggregate for Mortar: ASTM C 144.
   1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
   2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
   3. White-Mortar Aggregates: Natural white sand or crushed white stone, as required for mix design.
   4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color, where required for mix design.

   1. Fine Aggregates: ASTM C404, clean, sharp, natural sand free from loam, clay lumps, or other deleterious substances.
K. Epoxy Pointing Mortar: ASTM C 395, epoxy-resin-based material formulated for use as pointing mortar for limestone (and approved for such use by manufacturer of units); in color indicated or, if not otherwise indicated, as selected by Architect from manufacturer's colors.

L. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
1. Products:
   a. Addiment Incorporated; Mortar Kick.
   b. Euclid Chemical Company; Accelguard 80.
   c. Grace Construction Products; Morset.
   d. BASF, Inc.; Trimix-NCA.

M. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer.
1. Products:
   a. Grace Construction Products; Dry-Block Mortar Admixture.
   b. BASF, Inc.; Rheopel Mortar Admixture.
   c. Krete Industries, Krete Guard Mortar Mix.
   d. Euclid Chemical Co.; Blocktite Mortar Admixture.

N. Water: Clean, free of deleterious materials which would impair strength or bond and potable.
1) ASTM A653, G60 (0.60 oz. per sq.ft.)

e. Sheet metal ties or anchors in exterior walls or a mean relative humidity exceeding 75 percent
   1) ASTM A153, Class B (1.50 oz. per sq.ft.)

f. Steel plates and bars
   1) ASTM A153, Class B

4. For single wythe interior CMU walls, provide ladder type joint reinforcing fabricated with two W1.7 or 0.148 inch steel side rods and W1.7 or 0.148 inch cross rods. Joint reinforcing shall be placed in every other CMU joint or not more than 16 inches o.c.

5. For interior walls consisting of CMU backup and face brick or CMU veneer, provide ladder type joint reinforcing fabricated with three W1.7 or 0.148 inch steel side rods and W1.7 or 0.148 inch cross rods. Joint reinforcing shall be placed in every other CMU joint or not more than 16 inches o.c.

6. For multi-wythe interior walls consisting of two wythes of CMU, provide ladder type joint reinforcing fabricated with four W1.7 or 0.148 inch steel side rods and W1.7 or 0.148 inch cross rods. Joint reinforcing shall be placed in every other CMU joint or not more than 16 inches o.c.

7. Multi-wythe exterior walls consisting of CMU backup, insulated cavity, and exterior face brick or CMU veneer.
   a. When both wythes are to be constructed simultaneously:
      1) Provide ladder type joint reinforcing fabricated with three W1.7 or 0.148 inch steel side rods and W1.7 or 0.148 inch cross rods. Joint reinforcing shall be placed in every other CMU joint or not more than 16 inches o.c.

   b. When each wythe is to be constructed separately:
      1) Backup Wythe
         a) Provide adjustable ladder type joint reinforcing fabricated with two W1.7 or 0.148 inch steel side rods, W1.7 or 0.148 inch cross rods, 3/16 inch eyes and 3/16 inch double legged pintles. Longitudinal rods shall be spaced for each face shell of CMU; eye sections shall extend into wall's cavity, and pintles shall rest upon bed joints of veneer. Joint reinforcing shall be placed in every other CMU joint or not more than 16 inches o.c.

      2) Veneer Wythe (CMU)
         a) Provide ladder type horizontal joint reinforcing fabricated with two W1.7 or 0.148 inch steel side rods and W1.7 or 0.148 inch cross rods continuous joint. Joint reinforcing shall be placed in every other CMU joint or not more than 16 inches o.c.

   c. For multi-wythe walls in which the coursing in the face wythe does not align vertically with the coursing in the backup wythe use:
      1) Stone Tab 3700 with 1100 triangular ties; Wire-Bond, Charlotte, North Carolina.

d. For banding details in which CMU and clay masonry are combined:
   1) Refer to NCMA TEK 5-2A.
      a) Provide ladder type horizontal joint reinforcing fabricated with two W1.7 or 0.148 inch steel side rods and W1.7 or 0.148 inch cross rods. Reinforce joints separating two different materials.
8. For foundation walls consisting of two wythes of CMU, provide ladder type joint reinforcing fabricated with four W1.7 or 0.148 inch steel side rods and W1.7 or 0.148 inch cross rods. Joint reinforcing shall be placed in every CMU joint or no more than 8 inches o.c. Side rods shall align with face shells of CMU.

9. For single wythe foundation walls, provide ladder type joint reinforcing fabricated with two W1.7 or 0.148 inch steel side rods and W1.7 or 0.148 inch cross rods. Joint reinforcing shall be placed in every CMU joint or no more than 8 inches o.c.

10. For double wythe and cavity brick screen walls, provide ladder type joint reinforcing with four (4) W1.7 or 0.148 inch steel side rods and W1.7 or 0.148 inch cross rods. Joint reinforcing shall be placed no more than 16 inches o.c.

11. For joint reinforcing in walls, other than those described above, refer to Drawings for particular requirements.

12. All ladder type joint reinforcing shall have cross rods spaced at 16 inches o.c.

2.6 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in subsequent paragraphs that are made from materials that comply with subparagraphs below, unless otherwise indicated.

1. Mill-Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 641, Class 1 coating, provide in interior walls where humidity is less than 75 percent.

2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153, Class B-2 coating, unless otherwise noted.

3. Galvanized Steel Sheet: ASTM A 653, Commercial Steel, G60 (Z180) zinc coating, provide in interior walls where humidity is less than 75 percent.

4. Steel Sheet, Galvanized after Fabrication: ASTM A 1008, Commercial Steel, hot-dip galvanized after fabrication to comply with ASTM A 153, unless otherwise noted.

B. Adjustable Anchors for Connecting to Structure: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch diameter, hot-dip galvanized steel wire. Mill-galvanized wire may be used at interior walls, unless otherwise indicated.

2. Tie Section for Steel Frame: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.188-inch diameter, hot-dip galvanized steel wire. Mill-galvanized wire may be used at interior walls, unless otherwise indicated.

3. Connector Section for Concrete: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.097-inch thick, steel sheet, galvanized after fabrication. 0.064-inch thick, galvanized sheet may be used at interior walls, unless otherwise indicated.

C. Partition Top anchors: 0.097-inch thick metal plate with 3/8-inch diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

D. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins, unless otherwise indicated.


E. Stone Anchors: Fabricate dowels, cramps, and other stone anchors from stainless steel.
F. Adjustable Masonry-Veneer Anchors: Provide either screw-attached, masonry-veneer anchors with separate horizontal reinforcing.

1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:
   a. Structural Performance Characteristics: Capable of withstanding a 100-lbf (445-N) load in both tension and compression without deforming or developing play in excess of 0.05 inch.

2. Contractor's Option: Unless otherwise indicated, provide any of the following types of anchors:

3. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.
   a. Fabricate sheet metal anchor sections and other sheet metal parts from 0.067-inch thick, steel sheet, galvanized after fabrication.
   b. Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.188-inch diameter, hot-dip galvanized steel wire.
   c. Products:
      1) Dayton Superior Corporation, Dur-O-Wal Division; D/A 213 or D/A 210 with D/A 700-708.
      2) Heckmann Building Products Inc.; 315-D with 316 or Pos-I-Tie.
      3) Hohmann & Barnard, Inc.; DW-10, DW-10HS or DW-10-X.
      4) Wire-Bond; 1004, Type III or RJ-711.
      5) Sandell

4. Drill Screws: Provide either of the following types:
   a. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 diameter by length required to penetrate steel stud flange with not less than 3 exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B 117.
      1) Products:
         a) ITW Buildex; Teks Maxisal with Climaseal finish.
         b) Textron Inc., Textron Fastening Systems; Elco Dril-Flex with Stalgard finish.
         c) Wire-Bond; 4000 with Climaseal finish.
   b. Stainless-Steel Drill Screws for Steel Studs: Proprietary fastener consisting of carbon-steel drill point and 300 Series stainless-steel shank, complying with ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 diameter by length required to penetrate steel stud flange with not less than three exposed threads.
      1) Products:
         a) Dayton Superior Corporation, Dur-O-Wal Division; Stainless Steel SX Fastener.
         b) ITW Buildex; Scots long life Tek.
         c) ITW Buildex; Teks Maxisal with Climaseal finish.
         d) Textron Inc., Textron Fastening Systems; Elco Dril-Flex with Stalgard finish.
         e) Wire-Bond; SFS Stadler SX Fastener.
2.7 MISCELLANEOUS ANCHORS

A. Stabilization Anchors: Provide where masonry walls intersect concrete or existing masonry walls.
   1. Products:
      a. D/A 2200; Dur-O-Wal, Inc.
      b. Slip Set Stabilizer; Hohmann & Barnard, Inc.
      c. 1700; Wire-Bond

B. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153, Class C; of dimensions indicated.

C. Intersecting Masonry Wall Joint Reinforcing: Where interior masonry walls supported on slabs intersect masonry walls, provide hot dip galvanized 1/2 inch by 16 gauge mesh ties spanning horizontally.
   1. Products:
      a. No. 269 Wire Mesh Wall Tie; Dur-O-Wal, Inc.
      b. #MWT Mesh Wall Tie; Hohmann & Barnard, Inc.
      c. Wire Mesh 269; Heckman Building Products
      d. Wire Mesh Tie; Wirebond

2.8 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
   1. Reglets/Receivers: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with mitered and welded corners and junctions. Formed reglets must comply with requirements of Division 07 Section “Sheet Metal Flashing and Trim”.
      a. Manufacturers:
         1) Cheney Flashing Company, Inc.
         2) Fry Reglet Corporation.
         3) Heckmann Building Products Inc.
         4) Hickman, W.P. Company.
         5) Keystone Flashing Company, Inc.
         6) Sandell Manufacturing Company, Inc.
      b. Material: Stainless steel, 0.0187 inch thick, aluminum zinc alloy-coated steel, galvanized steel, 0.028 inch thick, or 0.028 inch thick prepainted, metallic-coated steel.
      c. Masonry Type: Provide extension leg to extend to face of inner CMU wythe or sheathing with a veneer wall configuration with an off set top flange.
   2. Metal Flashing Terminations: Fabricate from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 3/8 inch to form a stop for retaining sealant backer rod.
   3. Stainless steel end dams may also be used in conjunction with flexible flashing.

B. Flexible Flashing: For flashing not exposed to the exterior, use the following, unless otherwise indicated:
1. **EPDM Flashing**: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D 4637, 0.040 inch thick.
   a. **Accessories**: Provide preformed corners, end dams, and other special shapes and seaming products produced by membrane manufacturer.

C. **Solder and Sealants for Sheet Metal Flashings**: As specified in Division 07 Section "Sheet Metal Flashing and Trim."
   1. **Solder for Stainless Steel**: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
   2. **Elastomeric Sealant**: ASTM C 920, chemically curing silicone sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

D. **Adhesives, Primers, and Seam Tapes for Flashings**: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates. Prime exterior miscellaneous steel trim with zinc-rich primer.

E. **Termination Bar**: Manufacturer's standard predrilled stainless-steel or aluminum bars approximately 1 by 1/8 inch thick; with anchors.

2.9 **MISCELLANEOUS MASONRY ACCESSORIES**

A. **Compressible Filler/Thermal Break**: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene or urethane.
   1. **Products**:
      a. Neo-Seal IV 2218-3; Williams Products, Inc.
      c. #NS-Closed Cell Neoprene Sponge; Hohmann and Barnard, Inc.
      d. Neocell; IPCO
      e. #NS-Closed Cell; National Construction Materials Corp.
      f. Sandell Closed Cell Neoprene

B. **Preformed Control-Joint Gaskets**: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. **Bond-Breaker Strips**: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. **Weep/Vent Products**: Use one of the following, unless otherwise indicated:
   1. **Cellular Plastic Weep/Vent**: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.
      a. **Products**:
         1) Advanced Building Products Inc.; Mortar Maze weep vent.
         2) Dayton Superior Corporation, Dur-O-Wal Division; Cell Vents.
         3) Heckmann Building Products Inc.; No. 85 Cell Vent.
         4) Hohmann & Barnard, Inc.; Quadro-Vent.
5) Wire-Bond; Cell Vent, 3601.
6) Sandell Cell Vent

E. Cavity Drainage Material: Provide the following configuration:
1. Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
   a. Strips, full-depth of cavity and 10 inches (250 mm) wide, with dovetail shaped notches 7 inches (175 mm) deep that prevent mesh from being clogged with mortar droppings.
2. 40 mil polymeric reinforced, UV stable flashing membrane, extending 18” up the surface of all the back-up material. Provide factory formed inside and outside corners.
3. 28-gaagage, 304 stainless steel rolled and hemmed drip edge, attached to the membrane flashing, extending ½” beyond the face of the masonry veneer.
4. 1” x 1/8” aluminum termination bar, for securing the flashing membrane to the back-up material.
5. Weep / Vent product, as specified in this Section.
6. Products:
   a. Advanced Building Products Inc.; Mortar Break.
   b. Archovations, Inc.; CavClear Masonry Mat.
   c. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
   d. Mortar Net USA, Ltd.; Mortar Net.
   f. Sandell; Mortar Web.
   g. Keene Building Products, Driwal Mortar Deflection/Driwall Masonry Vent System.

F. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.142-inch steel wire, hot-dip galvanized after fabrication. Provide units with either two loops or four loops as needed for number of bars indicated.
   1. Products:
      a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
      c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.
      d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.

G. Column Isolation: Around all columns in masonry walls, provide 1/4 inch minimum isolation material to prevent the masonry from coming in contact with the displaced column during loading and to prevent mortar from being within the same joint.
   1. Contractor may provide standard column boxboard in lieu of wrap.
   2. Products:
      a. Ceramar Flexible Foam; W.R. Meadows, Inc.
      b. Econ-O-Foam; Williams Products
      c. Nomaboard; Nomaco Inc.
d. Column Backboard; Williams Products.

H. Grout Stop: Fiberglass, galvanized steel, or polypropylene screen.
   1. Products:
      a. DA1015 DUR-O-STOP; Dur-O-Wall, Inc.
      b. Metal Lath 268; Heckmann Building Products, Inc.
      c. MGS - Mortar/Grout Screen; Hohmann & Barnard, Inc.
      d. Grout Stop 3612; Wire-Bond
      e. Sandell Grout Stop

2.10 MASONRY CLEANERS AND ACCESSORIES

A. Sand for Acoustical Fill:
   1. Clean, dry, and acceptable to A/E.

B. Preformed Expansion Joint Filler: Provide closed cell sponge neoprene expansion joint filler conforming to ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated.

C. Bituminous Coating: Cold applied asphalt mastic complying with SSPC-Paint 12, except containing no asbestos fibers, or cold applied asphalt emulsion complying with ASTM D1187, Type II.

D. Masonry Cleaners
   1. Proprietary Acidic Cleaner: Manufacturer's standard strength, general purpose cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from masonry surfaces of type indicated below without discoloring or damaging masonry surfaces; expressly approved for intended use by manufacturer of masonry units being cleaned.
      a. For brick masonry not subject to metallic oxidation stains, use formulation consisting of a concentrated blend of surface acting acids, chelating, and wetting agents.
         1) Products:
            a) Sure Klean No. 600 Detergent; ProSoCo., Inc.
            b) 202 Detergent; Diedrich Technologies
            c) EaCo Chem, Inc.
      b. For dark colored brick masonry not subject to metallic oxidation stains, use formulation consisting of a liquid blend of surface acting acids and special inhibitors.
         1) Products:
            a) Sure Klean No. 101 Lime Solvent; ProSoCo., Inc.
            b) 200 Lime Solv; Diedrich Technologies
            c) EaCo Chem, Inc.
      c. For brick masonry subject to metallic oxidation stains, use formulation consisting of a liquid blend of organic acids and special inhibitors.
         1) Products:
            a) Sure Klean Vana Trol; ProSoCo., Inc.
            b) 202 Vana-Stop; Diedrich Technologies
            c) EaCo Chem, Inc.
d. For decorative concrete masonry units use a general purpose acidic cleaner to remove concrete splashes, excess mortar, mud, retarders, heavy efflorescence, embedded stains, rust, and surface soiling.
   1) Products:
   a) Sure Klean Custom Masonry Cleaner; ProSoCo., Inc.
   b) 202 Vana-Stop; Diedrich Technologies
   c) EaCo Chem, Inc.

e. For ground face (burnished) concrete masonry units, use a general purpose, nonetching acidic cleaner to remove rust, mud, oil, atmospheric dirt, mortar smears, and other stains without altering the surface texture.
   1) Products:
   a) Sure Klean Burnished Custom Masonry Cleaner; ProSoCo, Inc.
   b) 202 Vana-Stop; Diedrich Technologies.
   c) EaCo Chem, Inc.

E. Spray Equipment: Provide equipment for controlled spray application of water and chemical cleaners, if any, at rates indicated or recommended for pressure, measured at spray tip, and for volume. Adjust pressure and volume, as required, to ensure that damage to masonry does not result from cleaning methods.
   1. For chemical cleaner spray application, provide a low pressure tank or chemical pump suitable for the chemical cleaner indicated, equipped with a cone-shaped spray tip.
   2. For water spray application, provide a fan-shaped spray tip that disperses water at an angle of not less than 15 degrees.

2.11 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated. When specifically approved by the A/E, admixtures shall meet ASTM C1384 Standard Specification for Admixtures for Masonry Mortars.
   1. Do not use calcium chloride in mortar or grout.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
   1. For masonry below grade use Type M, where indicated only.
   2. For masonry, use Type S, unless otherwise noted.
   3. For exterior, above-grade, masonry veneer, use Type N, unless otherwise noted.

D. Use natural (noncolored) mortar for the following:
   1. Face brick, unless otherwise noted.
   2. Exterior (exposed) concrete masonry units, unless otherwise noted.
   3. Concrete masonry units, unless otherwise noted.

E. Use integral water repellent admixture at all exterior concrete masonry unit wythe locations, unless noted otherwise.
F. Pointing mortar shall conform to ASTM C270, except that all sand shall pass a No. 16 sieve. Nonstaining and dirt resistant mortar shall be used to which ammonium stearate or calcium stearate is added to the amount equal to 3 percent of the weight of the cement used.
   1. Pointing mortar shall be proportioned by volume with one part portland cement, 1/8 part Type S hydrated lime, and 2 parts graded (50 mesh or finer) sand to which ammonium stearate or calcium stearate is added in an amount equal to 2 percent of the weight of the cement used. Use mortar within 30 minutes of final mixing; do not retemper or use partially hardened material.
   2. Add colored mortar pigment to produce mortar colors required. Coordinate with CMU manufacturer to produce color required to match CMU unit for repair of face.
   3. Use pointing mortar to repair chipped CMU units.

G. Grout for Unit Masonry (by Strength): Comply with ASTM C 476. Grout mixes shall be designed by strength, unless specifically noted otherwise in the Contract Documents.
   1. General: Do not use admixtures, including pigment, air-entraining agents, accelerators, retarders, water repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated. Do not lower the freezing point of grout by use of admixtures or anti-freeze agents.
      a. Admixtures containing chlorides in excess of 0.2 percent chloride ions are not permitted to be used.
      b. Antifreezes are prohibited for use in grouts.
      c. Flyash: ASTM C618-89a, Type C or F may be substituted for up to 20 percent of the total cementitious materials in the gout mix.
   2. Grout mixes shall be plant mix or factory blended (dry mix with water added at the site).
      a. Field mixed grout designs are not acceptable.
   3. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
   4. Provide grout with a slump of 8 to 10 inches as measured according to ASTM C 143.

H. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.

2.12 SOURCE QUALITY CONTROL

A. Masonry Prism Tests (Empirical Design)
   1. Prior to installation of concrete masonry work, construct a set of 3 concrete masonry prisms, using mortar and concrete masonry units to be used in the masonry work. Construction prisms for concrete masonry units as required on the Reinforced Masonry Plan in the Drawings. Unless otherwise required, construct masonry prisms 8 inches by 8 inches by 16 inches high (nominal) in compliance with ASTM-E447, Method B.
   2. During masonry work construct additional prisms as required. Refer to Division 01 Section “Quality Requirements”.

B. Masonry Contractor shall water test cavity to verify all water is draining to the exterior through the weeps before continuing with exterior wythe before capping wall. Contractor is encouraged to water test as flashing is installed to minimize possible failures.
   1. Contractor shall perform tests in the presence of CM, (if applicable) A/E, testing lab representative, and General Contractor.
2. Contractor shall hold water hose and with standard water pressure force water into the cavity at a cell vent so water can be observed coming out adjacent weeps for a period of at least 5 minutes. Contractor shall continue down the wall to the next cell vent where a weep did not indicate water wicking out and continue this process until the entire length of flashing is tested.

3. Where water is observed inside the building or outside the building away from the weeps, masonry units shall be removed and flashing reinspected and repaired.

4. Water test shall be repeated where flashing was repaired.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
   1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
   2. Verify that foundations are within tolerances specified.
   3. Verify that reinforcing dowels are properly placed.
   4. Verify critical steel elevations to ensure flashing will be installed at proper locations.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
   1. Note: In lieu of double wythe foundation walls, single wythe matching nominal overall width of double wythe may be provided.

B. Build chases and recesses to accommodate items specified in this and other Sections. Provide not less than 8 inches of masonry between chases or recesses and jamb of openings, and between adjacent chases and recesses.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
   1. Mix units from several pallets or cubes as they are placed.
F. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

G. Comply with construction tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:
1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
2. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
3. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
4. For exposed bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch. Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
5. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
6. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.
7. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

H. Reinforcing Bars: Tolerances for placing reinforcing bars are:
1. Variation from $d$ for flexural elements (measured from center of reinforcement to the extreme compressive face of masonry):
   a. $d \leq 8$ inch $\pm 1/2$ inch
   b. $8$ inch $< d \leq 24$ inch $\pm 1$ inch
   c. $d < 24$ inch $\pm 1$ inch

2. For vertical bars in walls 2 inch from the location along the length of the wall indicated on the project drawings.
3. In addition, a minimum clear distance between reinforcing bars and the adjacent face of a masonry unit of 1/4 inch for fine grout or 1/2 inch for coarse grout must be maintained so that grout can flow around the bars.

3.3 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
1. Do not install cracked, broken, or chipped masonry units exceeding ASTM allowances.
2. Clean units of surface dirt and contaminants before placing in contact with mortar.
3. Lay-up walls plumb and true and with courses level, accurately spaced, within specified tolerances, and coordinated with other work. Do not wedge partitions tight against structural ceiling or beams, but provide a caulk or insulation filled joint between masonry and the structural roof deck, structural steel framing or structural floor deck at nonrated conditions. At rated walls, provide firestopping. Refer to Division 07 Section “Firestopping”.

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a. Cut masonry as required to maintain 2 inches clearance between masonry and all steel or reinforced concrete structural members that pass through or above walls, but are not to be supported by the walls.

4. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors, unless otherwise indicated.

B. Bond Pattern for Exposed Masonry: Lay exposed masonry in the following bond pattern; do not use units with less than nominal 4 inch horizontal face dimensions at corners or jambs.
1. One-half running bond with vertical joint in each course centered on units in courses above and below, unless otherwise noted.
2. Provide 1/4 running bond as required by Monarch size brick.
3. Provide special bonding as indicated on Drawings.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
1. Align unit cells or cores that are to be grouted.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
1. Install adjustable hollow metal frame anchors, locating anchors on jambs in horizontal bed courses near the top and bottom of each frame and at intermediate points not over 24 inches apart.
2. Fill jambs of hollow metal door and window frames solid with grout.
3. Rake joints around exterior side of exterior hollow metal door frames for sealant under Division 7.
4. Protect inside (concealed) faces of door frames in exterior masonry walls, using fibered asphalt emulsion coating. Apply over shop primer approximately 1/8 inch thick and allow drying before handling.
5. Where hollow metal frames do not wrap around masonry jambs and heads, rub exposed corners of block to remove sharp, irregular edges.
6. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of grout stop mesh in the joint below and rod mortar or grout into core.
7. Fill cores in hollow concrete masonry units with grout 3 courses (24 inches) under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.
8. Take particular care to embed all conduits and pipes with concrete masonry without fracturing exposed shells and to fit units around switch, receptacle and other boxes set in walls. Where electric conduits, outlets, switch boxes, and similar items occur, grind and cut units before building in services.
9. Install anchors, reglets, and nailers for flashing and related work built into masonry work, where indicated.
3.4 MORTAR BEDDING AND JOINTING

A. Mortar Bedding; Brick and Concrete Masonry Units as follows:
   1. Mix mortar ingredients for a minimum of 5 minutes in a mechanical batch mixer. Use water clear and free of deleterious materials that would impair the work. Each mortar batch is allowed only one retempering. Do not use mortar, which has begun to set after the first retempering, or if more than 2-1/2 hours has elapsed since initial mixing. Retempering will be permitted only within 1-1/2 hours of mixing, to replace moisture lost by evaporation. Discard any mortar or grout that is partially set.
   2. Lay brick and other solid masonry units with completely filled bed and head joints. Do not deeply furrow bed joints. Butter ends with sufficient mortar to fill head joints and shove into place. Butter ends of brick in hand and in the wall at closures. Do not slush head joints.
   3. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells; also bed webs in mortar in starting course on footings and foundation walls, in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be filled with grout.
      a. Construct bed joint of the starting course of foundation with a thickness not less than 1/4 inch and not more than 3/4 inch.
   4. Remove mortar protruding into cells or cavities that will be grouted. Do not permit mortar droppings to fall into cells, cavities of multi-wythe walls or to block weep holes. Maintain clear cavity width between facing and backing material and keep clear of mortar droppings by back beveling the mortar bed to prevent excess from extruding into cavity. Clean any excess that does occur by parging it to back of unit.
   5. Fill holes not specified in exposed and below grade masonry with mortar.

B. Set limestone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.
   1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
   2. Wet joint surfaces thoroughly before applying mortar.

C. Joints: Maintain joint widths shown, except for minor variations required, to maintain bond alignment. Lay walls with 3/8 inch joints. Tool joints consistently with the same type round jointer when the mortar is thumb print hard. Tool joints in exposed masonry walls at uniform moisture content to avoid color variations. Cut joints flush for masonry walls that are to be concealed or to be covered by other materials. For exposed masonry, provide joints as follows:
   1. Exterior Joints
      a. Concave tooled, unless otherwise noted.
      b. Provide tooled joints horizontal and vertical at exterior scored concrete masonry units.
   2. Interior (Room Side) Joints
      a. Concave tooled, unless otherwise noted.
      b. Rake vertical joints at interior masonry partitions abutting vertical structural framing members for application of joint sealants.

3.5 CAVITY WALLS

A. Bond wythes of cavity walls together using one of the following methods:
1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 2.67 sq. ft. of wall area spaced not to exceed 24 inches o.c. horizontally and 16 inches o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches o.c. vertically.
   a. Where bed joints of wythes do not align, use adjustable (two-piece) type ties.
   b. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type ties to allow for differential movement regardless of whether bed joints align.

   a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes, if both wythes are concrete masonry and installed simultaneously. At no time shall a wythe be more than 16 inches higher than any other wythe being constructed concurrently.
   b. Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties.
   c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align. Wythes may be laid up full height separate from facing wythe.

B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.
   1. Keep cavity clean of mortar droppings by suspending by wires a wooden strip the width of the air space. Strip shall be lifted as each course of joint reinforcement is laid in facing wythe. Install cavity mortar protection in cavity above through wall flashing and where indicated for additional protection.

C. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.
   1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry or butter all edges of insulation board with adhesive or seal gaps with tape as recommended by insulation board manufacturer to provide a continuous thermal barrier.

3.6 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
   1. Space reinforcement not more than 16 inches o.c., unless otherwise noted.
   2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
   3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings.
      a. Reinforcement above is in addition to continuous reinforcement.
B. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 ANCHORING MASONRY TO STRUCTURAL MEMBERS

A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:
   1. Provide an open space not less than 1 inch in width between masonry and structural member, unless otherwise indicated. Keep open space free of mortar and other rigid materials.
   2. Anchor masonry to structural members with anchors embedded in masonry joints and attached to structure.
   3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.8 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using one of the following methods:
   1. Fit bond-breaker strips into hollow contour in ends of concrete masonry units on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
   2. Install preformed control-joint gaskets designed to fit standard sash block.
   3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
   4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

C. Form expansion joints in brick made from clay or shale as follows:
   1. Build flanges of factory-fabricated, expansion-joint units into masonry, where indicated.
   2. Build in compressible joint fillers, unless otherwise noted.

D. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 07 Section "Joint Sealants," but not less than 3/8 inch.
   1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

E. Control Joint Locations in CMU: Provide vertical control joints in CMU where called for on the Drawings, in accordance with NCMA TEK Bulletins 10-1A, 10-2A, 10-2B, and 10-4, and at all offsets, returns, openings, and intersections with dissimilar materials and as follows to prevent cracking:
1. At change from wall setting on foundation to wall setting on floor slab.
2. At change from exterior wall to interior wall.
3. At walls setting on floors that cross floor construction.
4. At columns within masonry walls.
5. At changes in wall thickness.
6. Stop joint reinforcement bars on either side of control joints. Extend reinforcing bars in bond beams continuously through control joints and sleeves for bond break 18 inches each side of joint.
7. At end of lintel bearing on one end of openings less than or equal to 6'-4" and at both ends of openings greater than 6'-4".
8. Straight runs as indicated below, with spacing related to wall height as follows:
   a. Walls less than 8 feet: Not more than 3 times wall height.
   b. Walls 8 feet or higher: Maximum 24 feet.

F. Expansion Joint Locations in Brick: Provide vertical expansion joints in brick masonry at all offsets, returns, openings, intersections with dissimilar materials, and elsewhere as shown on Drawings and indicated hereinafter, and at not more than 24 feet on center. Provide horizontal expansion joints by placing a continuous 3/8 inch pad below shelf angles, where indicated.
1. At expansion joints shown in limestone or precast concrete panels laid into the brick wythe.
2. At one jamb of openings 12 feet or wider.
3. Form open joint of width indicated but not less than 3/8 inch for installation of preformed expansion joint filler, and sealant and backer rod specified in Division 07 Section “Joint Sealants”. Maintain joint free and clear of mortar.

G. Building Expansion Joint Through Masonry
1. Expansion joints indicated as 2 inches or less form an open joint for installation of expanding foam secondary sealant and sealant specified in Division 07 Section “Joint Sealants”. Maintain joint free and clear of mortar.
2. For expansion joints 2 inches and greater, refer to Division 05 Section “Expansion Joint Cover Assemblies”.

3.9 LINTELS

A. Install loose steel lintels furnished under Division 05.

B. Provide masonry lintels where shown and wherever openings of more than 8 inches for brick size units and 16 inches for block size units are shown without structural steel or other supporting lintels. Provide precast or formed-in-place masonry lintels. Do not use precast concrete lintels without A/E approval. Thoroughly cure precast lintels before handling and installation. Temporarily support formed-in-place lintels.
1. For hollow masonry, use specially formed "U"-shaped lintel units with reinforcing bars placed as shown and filled with coarse grout.
2. Bond pattern for masonry lintels shall match the pattern at the adjacent wall unless otherwise noted.

C. Provide minimum 8 inch solid bearing at each end, unless otherwise noted.

D. For steel lintels in exterior wythe of face brick, rake back mortar in preparation for sealant as specified in Division 07 Section “Joint Sealants”.

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E. Where formed-in-place masonry lintels are supported by steel angles over the opening during installation, the angles shall not extend more than 2-1/2 inches into the masonry on each jamb of the opening. When the angles are removed, the void remaining shall be packed tightly with a moist mixture of Type S mortar.

F. The reinforced masonry and lintel drawings are intended to show the major lintels required for windows, doors, louvers, and other major openings. Some lintels are shown for some mechanical duct and pipe openings, but the drawings are not intended to show all of these openings. The masonry contractor shall coordinate the size and location of openings required in masonry walls by the other contractors and provide steel or masonry lintels for these openings according to the lintel schedules in the Contract Documents whether shown on the Contract Documents or not.

3.10 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated. Comply with NCMA recommendations for “drainage wall system” masonry construction.

1. Install concealed through wall flashing in accordance with SMACNA “Architectural Sheet Metal Manual” Chapter 4 Flashing and with NCMA TEK Bulletins 19-4 and 19-5 details to ensure water resistant masonry construction.

B. Install flashing as follows, unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
   a. Install flashing/drainage system in accordance with manufacturer’s installation instructions.

2. At multiwythe masonry walls, including cavity walls, where wall intersects a roof or similar horizontal element, extend flashing through outer wythe, turn up a minimum of 8 inches and terminate on exterior face with termination bar and sealant. Install metal reglet/receiver, extending through cavity and turned up at exterior face of inner wythe, beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal reglet/receiver.
   a. Note: Embedded flashing must terminate a minimum of 12 inches above roofing surface. Coordinate termination with roofing contractor.

3. At multiwythe masonry walls, including cavity walls, where wall intersects grade, extend flashing through outer wythe, turn up a minimum of 8 inches and terminate on exterior face of inner wythe with termination bar and sealant. Cut flexible flashing off flush at face of wall after masonry wall construction in completed.

4. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under building paper or building wrap, lapping at least 4 inches and terminate with a termination bar and sealant. Terminate flashing at outer wythe using the same methods used at multiwythe masonry walls as specified hereinbefore.
5. At lintels and shelf angles, extend flashing over top flange of angle across air space behind veneer and turn up a minimum of 8 inches and terminate on exterior face of inner wythe or sheathing with termination bar and sealant. At outer wythe extend flashing at least 6 inches beyond end of lintel or shelf angle and turn up ends not less than 2 inches to form end dams. Install metal drip edges beneath flexible flashing at exterior face of wall and seal with sealant to lintel or shelf angle. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.

6. Flexible flashing must lap over the metal receiver or drip edge minimum dimension of 1” and must be fully bonded to top surface of the metal drip edge with mastic or manufactured approved sealant.

C. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
1. Use specified weep/vent products to form weep holes.
2. Space weep holes 16 inches o.c., unless otherwise indicated.

D. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.

E. Install vents in head joints in exterior wythes at 32 inches o.c., unless otherwise indicated. Use specified weep/vent products to form vents.
1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.11 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. The low-lift grouting procedure shall be used as described in the Drawings and in NCMA-TEK 3-2 Grouting for Concrete Masonry Walls and NEMA TEK Bulletins 3-3 and 14-2. Maximum height of grouting shall be 4 feet.
3. Grout (slump 8 to 10 inches) shall be installed in the block cavities so as to completely fill each cavity with homogenous grout, extending from the lowest course to the top of the reinforced portion of the foundation or wall. Concrete or mortar shall not be used as grout for CMU.
4. Between 5 and 20 minutes after the grout is placed, it shall be consolidated with a mechanical vibrator. The top of the grout filling shall be stopped 1-1/2 inches below the top of the concrete block to form a key, except for the top course in the wall where the grout shall be struck flush with the top.

5. Aggregate used in the grout shall be small enough not to interfere with placement and plasticity.

6. Caging devices and centering clips shall be spaced vertically such that 2 clips or devices, one near its top and one near its bottom restrain every section of vertical reinforcing bar.

7. Where grouted cores do not extend the full height of a wall, install grout stop mesh at the lower limit of the grout.

8. Where required on the plans, grouting operations shall be observed by an independent testing agency.

3.12 FIELD QUALITY CONTROL

A. Inspectors: Owner will engage qualified independent inspectors to perform inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections. Minimum qualifications for the masonry inspector shall be 5 years of reinforced masonry inspection experience or acceptance by a State, municipality, or other governmental body having a program of examining and certifying inspectors for reinforced masonry construction. The masonry inspector shall be present during preparation of masonry prisms, sampling and placing of masonry units, placement of reinforcement, inspection of grout space, immediately prior to closing of cleanouts, and during grouting operations. The masonry inspector shall assure Contractor compliance with drawings and specifications, including flashing. The masonry inspector shall keep a complete record of all inspections and shall submit Masonry Inspection Reports and Special Inspection requirements set forth in the structural drawings for inspection requirements and a photographic record of flashing.

1. Masonry Inspection: Provide masonry construction inspection of concrete or brick masonry walls indicated as requiring inspection on the Masonry Plans to insure that masonry construction is in conformance with the Contract Documents. Masonry inspection is required for those masonry elements that must be constructed to attain high design strengths.

   a. Inspection shall use NCMA-TEK 18-3 Quality Assurance as a guideline.
   b. The individual or individuals who will perform the masonry inspection shall be present for the Premasonry Conference.
   c. The masonry inspector shall prepare a written report or reports for each day of inspection. Masonry Inspection Report, following this Section, shall be used for all inspection reports. Inspecting reports shall be submitted to the Architect within 5 days of masonry inspection.
   d. The masonry inspector shall be present and observe all masonry construction operations in walls requiring inspection. The masonry inspector shall be present at the project site within sufficient time, in advance of grouting operations, to inspect the construction to insure its conformance to the Contract Documents and that grouting may proceed. No grouting shall be permitted unless the masonry inspector is present and has indicated that the masonry construction is properly prepared for the grouting operation.

B. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections indicated below and prepare test reports:

1. Payment for these services will be made by Owner.
2. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.

C. Concrete Masonry Unit Test: For each type of unit provided, per ASTM C 140.
   1. Tests of Concrete Masonry Prisms: The Masonry Contractor shall coordinate with a qualified testing laboratory to perform field quality control testing during the masonry work.
      a. When required by the Masonry Plan, construct a set of 3 masonry prisms using mortar and concrete masonry units to be used in the masonry work. Unless otherwise noted, construct prisms 8 inches by 8 inches by 16 inches high (nominal) in compliance with ASTM E447, Method B.
      b. When prism tests are required to establish the strength of masonry in lieu of Masonry Inspection, provide a minimum of one set of 3 masonry prisms for testing for each 5000 sq.ft. (gross) of masonry wall construction.
      c. Submit written reports for each prism tested. Provide the project identification name and number, date of report, name of Contractor, name of testing service, name of material suppliers, specific location where masonry represented by the prism is used, compression test strength results, and specified required strength.
      d. If the compressive strength tests fail to meet the minimum strength specified in the Plans, the masonry represented by the tests shall be considered deficient.
      e. When tests indicating deficient masonry represent masonry already constructed, such masonry shall be removed and replaced by the Contractor without additional cost to the Owner. In lieu of removal and replacement, additional cores may be grouted as required and directed by the Architect without additional cost to the Owner.

D. Mortar Test (Property Specification): For each mix provided, per ASTM C 780. Test mortar for mortar air content and compressive strength.
   1. Tests for Mortar: The Masonry Contractor shall coordinate with a qualified testing laboratory to perform field quality control testing during the masonry mortar work.
      a. For colored and noncolored mortars test for compressive strength by the methods of sampling and testing of ASTM C109 and ASTM C780.
         1) Provide a minimum of one set of cubes for testing per 5,000 sq.ft. of masonry wall construction or for each ready mix truckload of grout and as directed by Architect.
      b. Submit written reports for each material sampled and tested. Provide the project identification name and number, date of report, name of contractor, name of testing service, source of aggregates, material manufacturer and brand name for manufactured materials, values specified in the referenced specification for each material, and test results. Indicate whether or not material is acceptable for intended use.
      c. If the compressive strength tests fail to meet the minimum requirements specified; the mortar represented by such tests would be considered deficient in strength.
      d. Deficient mortar shall be removed and replaced by the Contractor without additional cost to the Owner.

E. Grout Test (Compressive Strength): For each mix provided, per ASTM C 1019.
1. Place a piece of preservative-treated wood 1-5/8 inch thick and 3 inch square on a level surface. For masonry units with permeable paper, such as absorptive paper toweling, taped to one face shell are placed around the wood block to form the mold. The resulting mold is approximately 3 inches square by 6 inches high. Measure and record the slump of the grout in accordance with Test Method C143. Pour grout into the mold in two layers. Rod each layer 15 times with a tamping rod to eliminate air bubbles. Rod the bottom layer throughout its depth. Distribute the strokes uniformly over the cross-section of the mold. For the upper layer, allow the stick to penetrate about 1/2 inch into the underlying layer. After the second lift is puddled, level the top of the specimen with a straightedge and immediately cover the specimens with wet burlap or similar material to keep it damp. Protect the specimens against disturbance and extreme changes in temperature, and after 48 hours, remove the masonry units and carefully pack the specimens for transport to the laboratory where they will be stored in a moist room until tested.

2. Cap the specimens in accordance with the applicable provisions of "Method of Capping Cylindrical Concrete Specimens," ASTM C617. The specimens should be tested in a damp condition in accordance with the applicable provisions of ASTM C39 "Methods of Test for Compressive Strength of Molded Concrete Cylinders."

3. Three test specimens shall be made and tested for each type of grout to be used in the work.

4. Tests for Grout: The Masonry Contractor shall coordinate with a qualified testing laboratory to perform field quality control testing during the masonry grout work.
   a. Grout for filling reinforced or unreinforced concrete masonry cores or brick cavities test for compressive strength. 
      1) Provide a minimum of one set of 3 test specimens for testing per 5,000 sq.ft. of masonry wall construction or for each ready mix truckload of grout and as directed by the Architect.
   b. Submit written reports for each material sampled and tested. Provide the project identification name and number, date of report, name of Contractor, name of testing service, source of aggregates, material manufacturer and brand name for manufactured materials, values specified in the referenced specification for each material, specific location where material represented by sample is used, slump and compression test results. Indicate whether or not material is acceptable for intended use.

F. Prism Test: For each type of construction provided, per ASTM C 1314 at 7 days and at 28 days.

3.13 REPAIRING, POINTING, AND CLEANING

A. During the cutting-in of new openings and installation of the new works, remove and replace existing face brick and masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement. New mortar shall match adjacent existing mortar with regard to color and tooling.
B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated. New mortar shall match adjacent existing mortar with regard to color and tooling.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints. Dry brush exposed masonry with bristle brushes at end of each work day.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   2. Test cleaning methods on sample wall panel; leave one-half of panel uncleared for comparison purposes or use methods used on approved mock-up. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
      a. Where walls are a combination of CMU and brick only the less aggressive CMU cleaners should be used.
   3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
   4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
      a. Remove efflorescence in accordance with brick manufacturer's recommendations. Cleaning agents may be used only with approval of masonry unit manufacturer. Cleaning agents must be same as those used on test area.
      b. If chemical cleaners are to be sprayed on, the pressure shall not exceed 50 psi.
   6. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
   7. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A and 8-3A, applicable to type of stain on exposed surfaces.
      a. If additional cleaning is necessary for special or prefaced CMU, consult with masonry unit manufacturer for approved method. Test method and gain A/E approval before proceeding.
      b. Water application method shall never exceed 400 psi without approval of A/E.
   8. Clean Concrete Stone Masonry (cast stone) and Architectural Stone Veneer (stacked stone) units to comply with recommendations in ILI's "Indiana Limestone Handbook."

END OF SECTION 042000
SECTION 05 0519 – POST-INSTALLED ANCHORS

PART 1 - GENERAL
When the information in this Specification Section conflicts with information on the Structural Construction Drawings, the Structural Construction Drawings shall prevail.

1.1 SUMMARY
A. Section Includes:
   1. Requirements pertaining to post-installed anchors for materials and equipment. This section pertains to all other sections of these specifications that require post-installed anchors unless specified otherwise.

1.2 RELATED SECTIONS
A. Section 03 1500 Concrete Accessories Cast-In Concrete Anchors
B. Section 018113 – Sustainability Requirements

1.3 DEFINITIONS
A. Adhesive: Chemical components formulated from organic polymers, or a combination of organic polymers and inorganic materials that cure when blended together
B. Adhesive anchor: A post-installed anchor, inserted into hardened concrete with an anchor hole diameter not greater than 1.5 times the anchor diameter, that transfers loads to the concrete by bond between the anchor and the adhesive, and bond between the adhesive and the concrete.
C. Edge Distance: The distance from the edge of the concrete surface to the center of the nearest anchor
D. Effective embedment depth: The overall depth through which the anchor transfers force to or from the surrounding concrete. The effective embedment depth will normally be the depth of the concrete failure surface in tension applications.
E. Expansion Anchor: A post-installed anchor, inserted into hardened concrete that transfers loads to or from the concrete by direct bearing or friction or both. Expansion anchors may be torque-controlled, where the expansion is achieved by a torque acting on the screw or bolt; or displacement-controlled, where the expansion is achieved by impact forces acting on a sleeve or plug and the expansion is controlled by the length of travel of the sleeve or plug.
F. Manufacturer’s Printed Installation Instructions (MPII): Published instructions for the correct installation of the anchor under all covered installation condition as supplied in the product packaging.
G. Post-installed anchor: An anchor installed in hardened concrete. Expansion, undercut, and adhesive anchors are examples of post-installed anchors.
H. Primary Structural System: The completed combination of elements which serve to support the building's self weight, the applicable live load which is based upon the occupancy and use of the spaces, and the environmental loads such as wind, seismic, and thermal. Curtain wall members, non-load bearing walls and exterior facade are examples of items which are not part of the Primary Structural System.
1.4 REFERENCES

A. ACI 318 – Building Code Requirements for Structural Concrete
B. ACI 355.2 – Qualification of Post-Installed Mechanical Anchors in Concrete
C. ACI 355.4 – Qualification of Post-Installed Adhesive Anchors in Concrete
D. ASTM E488 – Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements
E. ICC-ES AC01 – Acceptance Criteria for Expansion Anchors in Masonry Elements
F. ICC-ES AC58 – Acceptance Criteria for Adhesive Anchors in Masonry Elements
G. ICC-ES AC60 – Acceptance Criteria for Anchors in Unreinforced Masonry Elements
H. ICC-ES AC70 – Acceptance Criteria for Fasteners Power-Driven into Concrete, Steel and Masonry Elements
I. ICC-ES AC106 – Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements
J. ICC-ES AC193 – Acceptance Criteria for Mechanical Anchors in Concrete Elements
K. ICC-ES AC308 – Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements

1.5 PRE-INSTALLATION MEETINGS

A. Post Installed Anchors – Conduct a thorough training with the manufacturer or the manufacturer’s representative for the installer on the project. Training to consist of a review of the complete installation process for post installed anchors as detailed in the Quality Assurance section below.

1.6 DELEGATED DESIGN

A. Engage a qualified professional engineer registered in the State of Ohio, as defined in Section 01 4000 "Quality Requirements," to design anchors that are not part of the Primary Structural System.
B. For each non-structural application, provide data substantiating specified design requirements, signed and sealed by the qualified professional engineer.
C. Select anchor type appropriate to conditions and item being fastened.
D. If required loading capacity is not indicated on the drawings, determine required loading capacity in accordance with accepted engineering principles and as required by applicable code.
E. Confirm application requirements for cracked and uncracked concrete substrates.

1.7 ACTION SUBMITTALS

A. Submittals are to be in accordance with Conditions of the Contract and Division 1 Submittal Procedures Section.
B. Product specifications with recommended design values and physical characteristics for adhesive, expansion and undercut anchors. DO NOT SUBMIT MANUFACTURER’S ENTIRE PRODUCT CATALOG
C. Quality Assurance Submittals:
   1. ICC ES Evaluation Reports.
D. Manufacturer’s Printed Installation Instructions (MPII)
E. Installer Qualifications & Procedures: Submit a letter of procedure stating method of drilling, the product proposed for use, the complete installation procedure, manufacturer training date (see below), and a list of the personnel to be trained on anchor installation.
1.8 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Post Installed anchors shall be installed by an installer with at least three years of experience performing similar installations.

B. Installer Training: Contractor shall arrange for an anchor manufacturer’s representative to provide onsite installation training for all of their anchoring products specified. Shell + Meyer Associates, Inc. must receive documented confirmation that all of the contractor’s personnel who install anchors are trained prior to the commencement of installing anchors. Training to consist of a review of the complete installation process for post installed anchors, to include but not be limited to:
   1. hole drilling procedure
   2. hole preparation and cleaning technique
   3. adhesive injection technique and dispenser training/maintenance
   4. rebar dowel preparation and installation
   5. proof loading/torquing

C. Certifications: Unless otherwise authorized by the Engineer, anchors shall have the following certification:

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store anchors in accordance with manufacturer’s recommendations.

B. Anchoring adhesives must be stored at temperatures prescribed by the manufacturer and must not be used beyond the expiration date.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Hilti Corporation www.us.hilti.com 1-800-879-8000

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings

C. Substitutions
   1. Due to code mandated design requirements (ACI Appendix D) anchor substitutions will only be considered on a limited basis due to high variability of design values and reduction factors unique to each anchor.
   2. As a result of the increased design complexity for checking each unique anchor from an alternative mfr. Shell + Meyer cannot offer anchor substitution requests as part of its basic design services. The following options are available for substitution requests:
      a. The contractor can independently retain Shell + Meyer to provide additional design services required to determine the new installation requirements of the proposed anchor. Please be advised it is possible the requested anchor may not meet the required load demand.
      b. The contractor can submit calculations prepared by a structural engineer registered in the State of Ohio indicating the alternative anchor will provide the required
design loading. Shell + Meyer will provide the maximum required design loading (tension, shear, and/or moments) for design.

c. The alternative anchor calculations shall account for reduction factors unique to each manufacturer’s anchorage method. These factors include, but are not limited to the following: Reduction factors for cracked concrete, hole drilling and cleaning methods, spacing, edge distances, concrete thickness, installed temperature ranges (adhesives), concrete conditions (i.e. dry, saturated, wet), sustained loading, seismic loading, and concrete type.

2.2 MATERIALS

A. Fasteners and Anchors
   4. Carbon Steel Threaded Rod: ASTM A36; or ASTM A193 Grade B7; or ISO 898 Class 5.8.

2.3 POST INSTALLED ANCHORS IN CONCRETE SUBSTRATE

A. All post installed anchors shall be head marked with a length code
B. Anchors in concrete shall be designed in accordance with ACI 318 Appendix D
C. Expansion Anchors: Expansion type, torque-controlled, with impact section to prevent thread damage complete with required nuts and washers. Provide anchors with length identification markings conforming to ICC ES AC01 or ICC ES AC193. Type and size as indicated on Drawings.
   1. Expansion anchors shall meet the criteria of ACI 355.2
   2. Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel anchors with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1).
   3. Exterior Use: As indicated on the Drawings, provide stainless steel anchors. Stainless steel anchors shall be AISI Type 304 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. Stainless steel nuts shall conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.
   4. Where anchor manufacturer is not indicated, subject to compliance with requirements and acceptance by the Engineer, provide the following:
      a. Hilti Kwik Bolt TZ, ICC ESR-1917 (carbon steel and AISI Type 304 Stainless Steel).
D. Screw Anchors: Screw type. Pre-drilling of the hole requires a standard ANSI drill bit with the same diameter as the anchor and installing the anchor will be done with an impact wrench. Provide anchors with a diameter and anchor length marking on the head. Type and size as indicated on Drawings.
1. Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel anchors with zinc plating equivalent to DIN EN ISO 4042 (8μm min.).
2. Where anchor manufacturer is not indicated, subject to compliance with requirements and acceptance by the Engineer, provide the following:

E. Cartridge Injection Adhesive Anchors: Threaded steel rod, inserts or reinforcing dowels, complete with nuts, washers, polymer or hybrid mortar adhesive injection system, and manufacturer’s installation instructions. Type and size as indicated on Drawings.
1. Adhesive anchors shall meet the criteria of ACI 355.4
2. Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel threaded rods conforming to ASTM F1554 Grade 36, ASTM A 193 Type B7 or ISO 898 Class 5.8 with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1) [or carbon steel HIT TZ rods conforming to ASTM A510 with chemical composition of AISI 1038].
3. Exterior Use: As indicated on the Drawings, provide stainless steel anchors. Stainless steel anchors shall be AISI Type 304 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. All nuts shall conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.
4. Reinforcing dowels shall be A615 Grade 60.
5. Where anchor manufacturer is not indicated, subject to compliance with requirements and acceptance by the Engineer, provide one of the following:
   b. Hilti HIT-Z anchor rods with HIT-HY 200 Safe Set System for anchorage to concrete, ICC ESR-3187.

2.4 POST INSTALLED ANCHORS IN MASONRY SUBSTRATE

A. Adhesive Anchors for Grout-Filled Concrete Masonry Units
1. An adhesive anchor shall consist of: 1) threaded rod or reinforcing bar insert; and 2) adhesive formula. Threaded rod inserts shall meet the minimum requirements of ASTM F1554 Grade 36, ASTM A193 Grade B7, ASTM A193 Grade B6 (Type 410 Stainless Steel) or ASTM A193 Grade B8 and B8M (Types 304 and 316 Stainless Steel). Reinforcing bar inserts shall meet the minimum requirements of ASTM A615 Grade 40. For exterior exposure the insert shall be stainless steel. Inserts in contact with preservative-treated and fire-retardant-treated wood shall be zinc coated in accordance with ASTM A153 Class C or D or stainless steel or demonstrated through tests to be equivalent to the coatings described. Adhesives shall be injectable, two-component, cartridge-type systems dispensed and mixed through a static mixing nozzle supplied by the manufacturer. Acceptable installation and performance temperature ranges shall be verified with manufacturer’s literature prior to installation.
2. Adhesive anchors are post-installed anchors used to transmit structural loads by means of tension, shear, or a combination of both between: (a) connected structural elements; or (b) safety-related attachments and structural elements. Adhesive anchors shall be assigned allowable tension and shear loads for designs based on allowable stress design in fully grouted concrete masonry units. Adhesive anchors shall have an evaluation report issued by ICC-ES and have been tested and qualified for performance in grout-filled concrete masonry units in accordance ICC-ES AC58 for all mandatory tests.
3. Adhesive anchors for grout-filled concrete masonry units shall be:
a. Hilti HIT-HY 70
   1) Steel anchor shall be Hilti HAS-E continuously threaded rod or continuously deformed steel rebar

B. Adhesive Anchors for Hollow Concrete Masonry Units
   1. An adhesive anchor shall consist of: 1) threaded rod insert; 2) adhesive formula; and 3) carbon steel, stainless steel or plastic screen tube. Threaded rod inserts shall meet the minimum requirements of ASTM F1554 Grade 36, ASTM A193 Grade B7, ASTM A193 Grade B6 (Type 410 Stainless Steel) or ASTM A193 Grade B8 and B8M (Types 304 and 316 Stainless Steel). For exterior exposure the insert shall be stainless steel. Inserts in contact with preservative-treated and fire-retardant-treated wood shall be zinc coated in accordance with ASTM A153 Class C or D or stainless steel or demonstrated through tests to be equivalent to the coatings described. Adhesives shall be injectable, two-component, cartridge-type systems dispensed and mixed through a static mixing nozzle supplied by the manufacturer. Acceptable installation and performance temperature ranges shall be verified with manufacturer’s literature prior to installation.
   2. Adhesive anchors are post-installed anchors used to transmit medium duty, non-seismic loads to hollow concrete masonry units by means of tension, shear, or a combination of both. Adhesive anchors shall be assigned allowable tension and shear loads for designs based on allowable stress design in hollow concrete masonry units. Adhesive anchors shall have been tested and qualified for performance in hollow concrete masonry units.
   3. Adhesive anchors for hollow concrete masonry units shall be:
      a. Hilti HIT-HY 70
         1) Steel anchor shall be Hilti HAS-E continuously threaded rod or continuously deformed steel rebar (use with appropriately sized screen tube)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Install only if environmental conditions are in compliance with manufacturer’s recommendations for installation conditions

3.2 PREPARATION

A. Verify on-site training of installers has been completed
B. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors.
   1. Existing reinforcing bars in the structure may conflict with specific anchor locations. Unless noted on the drawings that the bars can be cut, the contractor shall review the existing structural drawings and shall undertake to locate the position of the reinforcing bars at the locations of the post installed anchors by Hilti Ferroscan, GPR, X-RAY, chipping, or other means.
   2. Exercise care in drilling to avoid damaging existing reinforcing or embedded items.
   3. Notify the Engineer if reinforcing steel or other embedded items are encountered during drilling.
   4. DO NOT DRILL THROUGH REINFORCING without first contacting the Engineer of Record.
   5. Take precautions as necessary to avoid damaging prestressing tendons, electrical and telecommunications conduit, and gas lines.
C. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

D. Clean holes for post installed anchors per MPII
   1. Where holes are drilled and cleaned in advance of anchor installation, it must be verified that the holes are protected from intrusion of contaminants or moisture (e.g., rainwater) during the interim period, or that the cleaning steps are performed immediately prior to anchor installation.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. General
   1. Adhesive anchors shall be installed in concrete having a minimum age of 21 days at time of anchor installation.
   2. Anchor capacity is dependent upon spacing between adjacent anchors and proximity of anchors to edge of concrete or masonry. Install anchors in accordance with spacing and edge clearances indicated on the drawings.

B. Perform anchor installation in accordance with MPII.

C. Where manufacturer recommends use of special tools for installation of anchors, such tools shall be used, unless otherwise permitted specifically by the Engineer of Record.

D. Drill holes for adhesive anchors with rotary impact hammer drills using carbide-tipped bits, or hollow drill bit system. Cored holes are not permitted for adhesive anchor applications. Drill bits shall be of diameters as specified by the anchor manufacturer. Unless otherwise shown on the Drawings, all holes shall be drilled perpendicular to the concrete surface.
   1. Cored Holes: Do not use cored holes for adhesive anchors. Where anchors are permitted to be installed in cored holes, use core bits with matched tolerances as specified by the manufacturer. Properly clean cored hole per manufacturer’s instructions.
   2. Base Material Strength: Unless otherwise specified, do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

E. Cartridge Injection Adhesive Anchors:
   1. Clean all holes per manufacturer instructions to remove loose material and drilling dust prior to installation of adhesive.
   2. Inject adhesive into holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
   3. Follow manufacturer recommendations to ensure proper mixing of adhesive components. Sufficient adhesive shall be injected in the hole to ensure that the annular gap is filled to the surface. Remove excess adhesive from the surface.
   4. Shim anchors with suitable device to center the anchor in the hole.
   5. Do not disturb or load anchors before manufacturer specified cure time has elapsed.

F. Observe manufacturer recommendations with respect to installation temperatures for cartridge injection adhesive anchors.

3.4 FIELD QUALITY CONTROL

A. The Architect/Engineer reserves the right to require the anchor manufacturer's representative to demonstrate proper installation procedures for post-installed anchors and to observe Contractor's installation procedures, at no extra cost to Owner.

B. The Architect/Engineer reserves the right to require pullout or shear tests to determine adequacy of anchors, at no extra cost to Owner.
C. Special Inspections – Owner will engage a qualified special inspector to perform the following special inspections:

1. Continuous special inspection – The special inspector shall observe all aspects of the anchor installation with the exception of holes drilled in the absence of the special inspector, provided the special inspector examines the drill bits used for the drilling and verifies the hole sizes.

2. Periodic special inspection – The special inspector shall verify the initial installation of each type and size of adhesive anchor by construction personnel on site in accordance with the items noted in the sections below. Subsequent installations of the same anchor type and size by the same construction personnel shall be permitted to be performed in the absence of the special inspector. Any change in the anchor product being installed or the personnel performing the installation shall require an initial special inspection in accordance with the requirements below. For ongoing installations over an extended period, the special inspector shall make regular inspections to confirm correct handling and installation of the product.

3. Mechanical Anchors – Periodically inspect and verify the following items:
   a. Hole drilling method in accordance with MPIII
   b. Anchor edge distance and spacing
   c. Hole diameter and depth
   d. Hole cleaning in accordance with the MPIII
   e. Anchor element type, material, diameter, and length
   f. Where anchors are installed in a slab on grade, check that the hole drilling procedures do not result in breaking through to the underside of the slab.
   g. Torque wrenches are calibrated properly
   h. Anchor threads are undamaged and not fouled
   i. During setting of torque-controlled expansion anchors, the inspector will note the number of full turns required to achieve the required torque

4. Cartridge injection Adhesive Anchors – Periodically inspect and verify the following items:
   a. Minimum concrete cure time of 21 days has passed
   b. Hole drilling method in accordance with MPIII
   c. Anchor edge distance and spacing
   d. Hole diameter and depth
   e. Hole cleaning in accordance with the MPIII
   f. Anchor element type, material, diameter, and length
   g. Anchor elements (threaded rod, reinforcing bars, internally threaded sleeves) are free of substances that might interfere with bond (e.g., dust, mud, oil)
   h. Reinforcing bars are free of loose rust
   i. Anchor threads are undamaged and not fouled
   j. Concrete temperature in-situ verified prior to installation for conformance with the requirements of the MPIII and to establish the cure time for the adhesive
   k. Adhesive identification and expiration date
   l. Adhesive installation in accordance with MPIII
   m. Anchor position is true (angle with respect to the concrete surface), and that the anchor is secured against movement during the cure time
3.5 REPAIR OF DEFECTIVE WORK

A. Remove and replace misplaced or malfunctioning anchors. Fill empty anchor holes and patch failed anchor locations with high-strength non-shrink, nonmetallic grout. Anchors that fail to meet proof load or installation torque requirements shall be regarded as malfunctioning.

END OF SECTION 05 0519
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Structural steel.
2. Prefabricated building columns.

1.3 RELATED WORK

A. Related Sections include the following:

1. Section 014000 "Quality Requirements" for independent testing agency procedures and administrative requirements.
2. Section 053100 "Steel Deck" for field installation of shear connectors.
3. Section 055000 "Metal Fabrications" for steel lintels or shelf angles not attached to structural-steel frame, miscellaneous steel fabrications, and other metal items not defined as structural steel.
4. Sections 099113, 099123 and 099600 “Painting”, surface preparation and priming requirements.

B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.4 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.

B. Architecturally Exposed Structural Steel: Structural steel designated as architecturally exposed structural steel in the Contract Documents.
1.5 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand loads indicated and comply with other information and restrictions indicated.

1. Engineering Responsibility:
   a. Fabricator's responsibilities include using a qualified professional engineer to prepare structural analysis data for structural-steel connections. See Section 1.5 B for additional responsibilities and requirements.
   b. The beam-column joints of the Special Moment Frames must be designed to comply with prequalified joint requirements per AISC 341-05 and AISC 358-05. A prequalification record for each joint must be prepared per Section P of AISC 358-05.

2. Contractor's Responsibility:
   a. Each contractor responsible for the construction of the seismic lateral resisting system shall provide a written statement to the engineer of record prior to the commencement of work. This statement shall include the following:
      Contractor(s) acknowledgement of Contractor Documents and Special Inspection requirements required by Appendix Q of AISC 358-05, Quality Assurance Plan.
      Acknowledgement that control will be exercised to ensure conformance with the approved construction documents.
      Procedure for exercising control within the contractor’s organization, the method and frequency of reporting and the distribution of reports.
      Identify the person exercising such control in the contractor’s organization and their position.
   b. The contractor shall ensure that the required special inspections are being carried and the proper documentation is being provided to the owner, Architect/Engineer and the Structural Engineer of Record as described above.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Submit fabrication drawings of structural steel components for approval prior to fabrication. Fabrication drawings shall not be reproductions of contract drawings.

1. Fabrication drawings shall be signed and sealed by a professional engineer registered in the State of Illinois.
2. Prepare drawings in accordance with AISC 326, AISC 325 and AISC 317.
3. Structural steel members, connection and components that are part of the seismic lateral resisting system shall be designed in accordance with AISC 341-05 and AISC 358-05.
4. Complete information for the fabrication and erection of the structural components, including locations of bolts, bolt size, bolt type, welds, member sizes, member lengths, connection details, blocks, copes and cuts shall be provided and represented.
5. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
6. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Welding Procedure Specifications shall be provided for all welding procedures designed as part of the Lateral Resisting System per AISC 358-05, Appendix Q.
7. Shoring and temporary bracing plan shall be designed and sealed by a professional engineer registered in the State of Illinois and submitted with calculations as part of the fabrication drawing submittal.
8. Member substitutions that deviate from the plan and details of the contract documents must be highlighted on the fabrication with an explanation for the reasons the deviations.
9. For structural steel connections indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer, licensed as a Structural Engineer in the state of Illinois, responsible for their preparation. Connections not detailed shall be designed in accordance with AISC 360 for 3/4 of the allowable load on the member, as defined in the AISC tables for allowable uniform load on the beams as $Wc/2L$.

C. Welding certificates.

D. Qualification Data: For Installer, fabricator, professional engineer, testing agency.

E. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:
   1. Structural steel including chemical and physical properties.
   2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
   3. Direct-tension indicators.
   4. Shear stud connectors.
   5. Shop primers.

F. Source quality-control test reports.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

B. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
C. Shop-Painting Applicators: Qualified according to AISC’s Sophisticated Paint Endorsement SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."

D. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

E. Comply with applicable provisions of the following specifications and documents:
   1. AISC's "Code of Standard Practice for Steel Buildings and Bridges."
   4. AISC's "Specification for the Design of Steel Hollow Structural Sections."

F. Inspections: Provide the special inspections, performed by an independent testing agency hired by the Architect/Engineer, as required by Chapter 17 of the IBC and Section Q of the AISC 358-05 Standard. The required inspections are outline in the Required Special Inspection Program on Sheet S0.03 of the Structural Drawings.

G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.

   1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
   2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.9 COORDINATION

A. Furnish anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.
PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A992 or ASTM A572, Grade 50 (345).
B. Channels, Angles, MC, S-Shapes: ASTM A36
C. Plate and Bar: ASTM A36, except components of the Lateral Resisting System shall be ASTM A572, Grade 50 material, unless otherwise noted.
D. Cold-Formed Hollow Structural Sections: ASTM A500, Grade B, structural tubing.
E. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
   1. Weight Class: Standard, unless otherwise noted.
   2. Finish: Black, except where indicated to be galvanized.
F. Welding Electrodes: E70XX, Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
   1. Finish: Plain.
   2. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type.
      a. Finish: Plain.
B. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.
C. Unheaded Anchor Rods: ASTM F 1554, Grade 36, unless otherwise specified
   5. Finish: Plain.
D. Headed Anchor Rods: ASTM F 1554, Grade 36 straight, unless otherwise specified
E. Threaded Rods: ASTM A 36 and ASTM A 449
   3. Finish: Plain.

2.3 PRIMER
   A. Primer: SSPC-Paint 15, Type I, iron oxide, zinc oxide, raw linseed oil, and alkyd.
   B. Galvanizing Repair Paint: ASTM A 780.

2.4 GROUT
   A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION
      1. Camber structural-steel members where indicated.
      2. Identify high-strength structural steel according to ASTM A 6/ A 6M and maintain markings until structural steel has been erected.
      3. Mark and match-mark materials for field assembly.
      4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
   B. Architecturally Exposed Structural Steel: Comply with fabrication requirements, including tolerance limits, of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel identified as architecturally exposed structural steel.
      1. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting, rust, scale, seam marks, roller marks, rolled trade names, and roughness.
      2. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.
   C. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
      1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.
D. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces.

E. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

F. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 3, "Power Tool Cleaning."

G. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

H. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
   1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
   2. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
   3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened, unless indicated as pretensioned, or Slip critical.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
   1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
   2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
   3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
      a. Grind butt welds flush.
      b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.
2.7 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded.
3. Surfaces to be high-strength bolted with slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials.
5. Galvanized surfaces.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

1. SP-1 “Solvent Cleaning”
2. SP-2 “Hand-Tool Cleaning”
3. SP-3 “Power-Tool Cleaning”

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.

D. Painting: Apply a 1-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils (0.038 mm).

2.8 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/ A 123M.

1. Fill vent holes and grind smooth after galvanizing.
2. Galvanize lintels and shelf angles attached to structural-steel frame and located in exterior walls.

2.9 SOURCE QUALITY CONTROL

A. The Architect/Engineer will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:

   1. Liquid Penetrant Inspection: ASTM E 165.
   2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
   4. Radiographic Inspection: ASTM E 94.

E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1 for stud welding and as follows:

   1. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
   2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.

   1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.
3.3 ERECTION


1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
2. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.
3. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.

G. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1.

H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
1. Joint Type: Snug tightened, unless indicated as pretensioned or slip critical.

   B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.


      2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.

      3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

      4. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.

         a. Grind butt welds flush.

         b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

3.5 FIELD QUALITY CONTROL

   A. Testing Agency: The Construction Manager will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.

   B. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

   C. Welded Connections: Field welds will be visually inspected according to AWS D1.1.

      1. In addition to visual inspection, field welds will be tested according to AWS D1.1 and the following inspection procedures, at testing agency's option:

         a. Liquid Penetrant Inspection: ASTM E 165.

         b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.

         c. Ultrasonic Inspection: ASTM E 164.

         d. Radiographic Inspection: ASTM E 94.

   D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

   A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

C. Touchup Painting: Cleaning and touchup painting are specified in Division 9 painting Sections.

END OF SECTION 05 12 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   2. KCS-type K-series steel joists.

B. Related Requirements:
   1. Section 033000 "Cast-in-Place Concrete" for installing bearing plates in concrete.
   2. Section 042000 "Unit Masonry" for installing bearing plates in unit masonry.
   3. Section 051200 "Structural Steel Framing" for field-welded shear connectors.

1.3 DEFINITIONS

A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."

B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.4 ACTION SUBMITTALS

A. Product Data: For each type of joist, accessory, and product.

B. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
   2. Laboratory Test Reports for Credit EQ 4: For primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
C. Shop Drawings:
   1. Include layout, designation, number, type, location, and spacing of joists.
   2. Include joining and anchorage details, bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.
   3. Indicate locations and details of bearing plates to be embedded in other construction.

1.5 INFORMATIONAL SUBMITTALS
A. Qualification Data: For professional engineer.
B. Welding certificates.
C. Manufacturer certificates.
D. Mill Certificates: For each type of bolt.
E. Comprehensive engineering analysis of special joists signed and sealed by the qualified professional engineer responsible for its preparation.

1.6 QUALITY ASSURANCE
A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications."
   1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.
B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 DELIVERY, STORAGE, AND HANDLING
A. Deliver, store, and handle joists as recommended in SJI's "Specifications."
B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated.
   1. Use ASD; data are given at service-load level.
2. Design special joists to withstand design loads with live-load deflections no greater than the following:

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.2 K-SERIES STEEL JOISTS


B. Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.

C. Provide holes in chord members for connecting and securing other construction to joists.

D. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated, complying with SJI's "Specifications."

E. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated, complying with SJI's "Specifications."

F. Do not camber joists.

G. Camber joists according to SJI's "Specifications."

H. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

2.3 PRIMERS

A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Primer: SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.

C. Primer: Provide shop primer that complies with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
2.4 JOIST ACCESSORIES

A. Bridging: Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.

B. Bridging: Schematically indicated. Detail and fabricate according to SJI's "Specifications. Furnish additional erection bridging if required for stability.

C. Fabricate steel bearing plates from ASTM A 36/A 36M steel with integral anchorages of sizes and thicknesses indicated. Shop prime paint.

D. Steel bearing plates with integral anchorages are specified in Section 055000 "Metal Fabrications."

E. Furnish ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction. Extend ends to within 1/2 inch (13 mm) of finished wall surface unless otherwise indicated.

F. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.

   1. Finish: Plain, uncoated.

G. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts; ASTM A 563 (ASTM A 563M) heavy hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M) hardened carbon-steel washers.

   1. Finish: Plain.

H. Welding Electrodes: Comply with AWS standards.

I. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.

J. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.5 CLEANING AND SHOP PAINTING

A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.

B. Do not prime paint joists and accessories to receive sprayed fire-resistive materials.

C. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil (0.025 mm) thick.
D. Shop priming of joists and joist accessories is specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written recommendations, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
4. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads are applied.

C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

D. Bolt joists to supporting steel framework using carbon-steel bolts.


F. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.
3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and bolted connections and to perform field tests and inspections and prepare test and inspection reports.

B. Visually inspect field welds according to AWS D1.1/D1.1M.

   1. In addition to visual inspection, test field welds according to AWS D1.1/D1.1M and the following procedures, as applicable:

      a. Liquid Penetrant Inspection: ASTM E 165.
      b. Magnetic Particle Inspection: ASTM E 709.

C. Visually inspect bolted connections.

D. Correct deficiencies in Work that test and inspection reports have indicated are not in compliance with specified requirements.

E. Perform additional testing to determine compliance of corrected Work with specified requirements.

3.4 PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists, bearing plates, abutting structural steel, and accessories.

   1. Clean and prepare surfaces by hand-tool cleaning according to SSPC-SP 2, or power-tool cleaning according to SSPC-SP 3.
   2. Apply a compatible primer of same type as primer used on adjacent surfaces.

C. Touchup Painting: Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

D. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that joists and accessories are without damage or deterioration at time of Substantial Completion.
SECTION 05 31 00 - STEEL DECK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes:
       1. Acoustical Roof deck.

1.3 RELATED WORK
   A. Related Sections include the following:
       1. Section 033000 "Cast-in-Place Concrete" for concrete fill and reinforcing steel.
       2. Section 051200 "Structural Steel" for shop-welded shear connectors.
       3. Section 055000 "Metal Fabrications" for framing deck openings with
          miscellaneous steel shapes.
       4. Sections 099113 and 099123 "Painting" for repair painting of painted deck.
   B. Related Documents:
       1. Drawings and general provisions of the Contract, including General and
          Supplementary Conditions and Division 1 Specification Sections, apply to this
          Section.

1.4 SUBMITTALS
   A. Product Data: For each type of deck, accessory, and product indicated.
   B. LEED Submittals:
       1. Product Data for Credit MR 4: For products having recycled content,
          documentation indicating percentages by weight of postconsumer and
          preconsumer recycled content. Include statement indicating cost for each
          product having recycled content.
       2. Laboratory Test Reports for Credit EQ 4: For primers, documentation indicating
          that products comply with the testing and product requirements of the California
          Department of Health Services' "Standard Practice for the Testing of Volatile
Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, deck openings, special jointing, accessories, and attachments to other construction.

D. Product Certificates: Signed by steel deck manufacturers certifying that products furnished comply with requirements.

E. Welding Certificates: Copies of certificates for welding procedures and personnel.

F. Product Test Reports: From a qualified testing agency indicating that each of the following complies with requirements, based on comprehensive testing of current products:

1. Mechanical fasteners.
2. Acoustical roof deck

G. Research/Evaluation Reports: Evidence of steel deck's compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed steel deck similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.


D. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those steel deck units tested for fire resistance per ASTM E 119 by a testing and inspection agency acceptable to authorities having jurisdiction.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
2. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.

E. AISI Specifications: Calculate structural characteristics of steel deck according to AISI's "Specification for the Design of Cold-Formed Steel Structural Members."

1.6 DELIVERY, STORAGE, AND HANDLING
A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
   1. Protect and ventilate acoustical cellular roof deck with factory installed insulation to maintain insulation free of moisture.

1.7 COORDINATION
A. Coordinate installation of sound-absorbing insulation strips in topside ribs of acoustical deck with roofing installation specified in Division 7 to ensure protection of insulation strips against damage from effects of weather and other causes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work. Whereso referenced, specific manufacturer products shall be employed. Suitable manufacturers are:
   1. Steel Deck:
      a. BHP Steel Building Products USA Inc.
      b. Consolidated Systems, Inc.
      c. Epic Metals Corp.
      d. Marlyn Steel Products, Inc.
      e. Nucor Corp.; Vulcraft Div.
      f. Roof Deck, Inc.
      g. United Steel Deck, Inc.
      h. Verco Manufacturing Co.
      i. Wheeling Corrugating Co.; Div. of Wheeling-Pittsburgh Steel Corp.

2.2 ACOUSTICAL ROOF DECK
A. Acoustical Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
1. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), **Grade 33 (230)** minimum, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.

   a. Color: **Gray top surface with white underside.**

2. Deck Profile: **Type WR, wide rib.**

3. Profile Depth: **1-1/2 inches (38 mm).**

4. Design Uncoated-Steel Thickness: **0.0358 inch (0.91 mm).**

5. Span Condition: **Triple span.**

6. Side Laps: **Overlapped.**

7. Acoustical Perforations: **Deck units with manufacturer's standard perforated vertical webs.**

8. Sound-Absorbing Insulation: Manufacturer's standard premolded roll or strip of glass or mineral fiber.

   a. Factory install sound-absorbing insulation into cells of cellular deck.

9. Acoustical Performance: **NRC 0.65**, tested according to ASTM C 423.

### 2.3 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Steel Sheet Accessories: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.

G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.

H. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck, with 3-inch- (76-mm-) wide flanges and sloped recessed pans of 1-1/2-inch (38-mm) minimum depth. For drains, cut holes in the field.

I. Flat Sump Plate: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck. For drains, cut holes in the field.
J. Repair Paint: Lead- and chromate-free rust-inhibitive primer complying with performance requirements of FS TT-P-664.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 29, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels, if required to meet deflection limitations.

C. Locate decking bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to decking.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of decking, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck. Submit to Engineer for approval of any substitutions. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 ROOF-DECK INSTALLATION

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated:

1. Weld Washers: Install weld washers at each weld location.
2. Weld Diameter: 5/8” diameter. See drawings for spacing.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding 18 inches (457 mm):
   1. Mechanically fasten with self-drilling, No. 10 (4.8-mm-) diameter or larger, carbon-steel screws.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:
   1. End Joints: **Lapped 2 inches (51 mm) minimum.**

D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and mechanically fasten flanges to top of deck. Space mechanical fasteners not more than 12 inches (305 mm) apart with at least one fastener at each corner.
   1. Install reinforcing channels or zees in ribs to span between supports and mechanically fasten.

E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Mechanically fasten to substrate to provide a complete deck installation.
   1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

3.4 FIELD QUALITY CONTROL

A. Testing: The Owner will engage a qualified independent testing agency to perform field quality-control testing.

B. Field welds will be subject to inspection.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Remove and replace work that does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.5 REPAIRS AND PROTECTION

A. Repair Painting: Wire brushing, cleaning and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Division 9 Section
B. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.
SECTION 05 40 00 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Exterior load-bearing wall framing.
   2. Interior load-bearing wall framing.
   4. Roof rafter framing.
   5. Ceiling joist framing.

B. Related Sections include the following:
   1. Division 05 Section "Metal Fabrications" for masonry shelf angles and connections.
   2. Division 09 Section "Non-Structural Metal Framing" for interior non-load-bearing, metal-stud framing and ceiling-suspension assemblies.
   3. Division 09 Section "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design exterior non-loading bearing light-gauge metal stud framing with connections and its’ attachment to structure, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Provide cold-formed metal framing capable of withstanding design loads within limits and under conditions indicated.

   1. Design Loads:

      See Structural General Notes Sheets S-001 and S-002 for applicable design codes and loading information.

   2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:

      a. Exterior Load-Bearing Wall Framing: Horizontal deflection of 1/480 of the wall height.
b. Interior Load-Bearing Wall Framing: Horizontal deflection of 1/360 of the wall height under a horizontal load of 5 lbf/sq. ft.
c. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/480 of the wall height.
d. Roof Rafter Framing: Horizontal deflection of 1/360 of the horizontally projected span.
e. Ceiling Joist Framing: Vertical deflection of 1/360 of the span.

3. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F

4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:


C. Cold-Formed Steel Framing, General: Design according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions."

1. Headers: Design according to AISI's "Standard for Cold-Formed Steel Framing - Header Design."
2. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

1.4 SUBMITTALS

A. Product Data: For each type of cold-formed metal framing product and accessory indicated.

B. Shop Drawings: Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

1. For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Welding certificates.

D. Qualification Data: For testing agency.

E. Product Test Reports: From a qualified testing agency, unless otherwise stated, indicating that each of the following complies with requirements, based on evaluation of comprehensive tests for current products:

1. Steel sheet.
2. Expansion anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

F. Research/Evaluation Reports: For cold-formed metal framing.

1.5 QUALITY ASSURANCE

A. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this Project in material, design, and extent.

C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated.

D. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, ductility, and metallic-coating thickness.


F. Fire-Test-Response Characteristics: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

G. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."
   1. Comply with AISI's "Standard for Cold-Formed Steel Framing - Truss Design."
   2. Comply with AISI's "Standard for Cold-Formed Steel Framing - Header Design."

H. Comply with AISI's "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings."

I. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE, AND HANDLING
A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering cold-formed metal framing that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide cold-formed metal framing by one of the following:

1. Allied Studco.
2. AllSteel Products, Inc.
4. Clark Steel Framing.
5. Consolidated Fabricators Corp.; Building Products Division.
6. Craco Metals Manufacturing, LLC.
7. Custom Stud, Inc.
8. Dale/Incor.
10. Dietrich Metal Framing; a Worthington Industries Company.
11. Formetal Co. Inc. (The).
12. Innovative Steel Systems.
13. MarinoWare; a division of Ware Industries.
15. SCAFCO Corporation.
18. Steeler, Inc.
20. United Metal Products, Inc.

2.2 MATERIALS

A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than [25] <Insert number> percent.

B. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:
1. Grade: As required by structural performance.
2. Coating: G90 or equivalent.

C. Steel Sheet for Vertical Deflection Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:
   1. Grade: As required by structural performance.
   2. Coating: G90.

2.3 EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness: 0.0566 inch.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
   1. Minimum Base-Metal Thickness: 0.0566 inch.
   2. Flange Width: 1-1/2 inches.

C. Vertical Deflection Clips: Manufacturer's standard bypass or head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Dietrich Metal Framing; a Worthington Industries Company.
      b. MarinoWare, a division of Ware Industries.
      c. SCAFCO Corporation
      d. The Steel Network, Inc.

D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal and lateral loads and transfer them to the primary structure, and as follows:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   
a. Dietrich Metal Framing; a Worthington Industries Company.
   b. MarinoWare, a division of Ware Industries.
   c. SCAFCO Corporation
   d. The Steel Network, Inc.

3. Minimum Base-Metal Thickness: 0.0677 inch.

4. Flange Width: 2-1/2” inches.

E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.

1. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal and lateral loads and transfer them to the primary structure, and as follows:
   2. Minimum Base-Metal Thickness: 0.0677 inch.
   3. Flange Width: 2-1/2” inches.
   4. Inner Track: Of web depth indicated, and as follows:
      a. Minimum Base-Metal Thickness: 0.0677 inch.
      b. Flange Width: 3-1/2” inches.

F. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure.

2.4 CEILING JOIST FRAMING

A. Steel Ceiling Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch.

2.5 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Foundation clips.
7. Gusset plates.
8. Stud kickers, knee braces, and girts.
9. Joist hangers and end closures.

2.6 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.

B. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.

C. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.

E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.

1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

2.7 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A 780.

B. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

C. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and 30-minute working time.

D. Shims: Load bearing, high-density multimonomer plastic, nonleaching.
E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.8 FABRICATION

A. Fabricate cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
   a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads.

4. Fasten other materials to cold-formed metal framing by welding, bolting, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

C. Install load bearing shims or grout between the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations to ensure a uniform bearing surface on supporting concrete or masonry construction.

D. Install sealer gaskets to isolate the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

A. Cold-formed metal framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.

D. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

   a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place,
undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.

H. Install insulation, specified in Division 07 Section "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.

J. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.

B. Fasten both flanges of studs to top and bottom track, unless otherwise indicated. Space studs as follows:

1. Stud Spacing: 16 inches on center.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Install single-leg deflection tracks and anchor to building structure.
2. Install double deep-leg deflection tracks and anchor outer track to building structure.
3. Connect vertical deflection clips to bypassing and/or infill studs and anchor to building structure.
4. Connect drift clips to cold formed metal framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.

1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of flat, taut, steel sheet straps of width and thickness indicated and stud or stud-track solid blocking of width and
thickness matching studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.

a. Install solid blocking at centers indicated on Shop Drawings.

2. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.

3. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.

4. Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable wall-framing system.

3.5 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Remove and replace work where test results indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.6 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.
SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous steel framing and supports.
2. Shelf angles.
3. Metal ladders.
4. Miscellaneous steel trim.
5. Metal bollards.

B. Products furnished, but not installed, under this Section:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

1.2 RELATED SECTIONS

A. Section 018113 – Sustainability Requirements

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design ladders, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Paint products.
2. Grout.

B. LEED Submittals:
1. Product Data for Credit MR 4.1 and Credit MR 4.2: Indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.

C. Shop Drawings: Show fabrication and installation details for metal fabrications.

1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces without blemishes.

2.2 FERROUS METALS

A. Recycled Content of Steel Products: Provide products with average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.

D. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

E. Rolled-Stainless-Steel Floor Plate: ASTM A 793.

F. Steel Tubing: ASTM A 500, cold-formed steel tubing.

G. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.

H. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M.

2.3 NONFERROUS METALS

A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.


C. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.
2.4 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls.

1. Provide stainless-steel fasteners for fastening aluminum.
2. Provide stainless-steel fasteners for fastening stainless steel.
4. Provide bronze fasteners for fastening bronze.

B. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

C. Post-Installed Anchors: Torque-controlled expansion anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.

2.5 MISCELLANEOUS MATERIALS

A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.


E. Concrete: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa).

2.6 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces.
B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.

C. Weld corners and seams continuously to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended.

D. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Locate joints where least conspicuous.

E. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

F. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors not less than 24 inches (600 mm) o.c.

2.7 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

2.8 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and installation within masonry walls.

B. Galvanize shelf angles located in exterior walls.

C. Prime shelf angles located in exterior walls with zinc-rich primer.

D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.9 METAL LADDERS

A. General:
   2. For elevator pit ladders, comply with ASME A17.1/CSA B44.

B. Aluminum Ladders:
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
   a. ACL Industries, Inc.
   b. Alco-Lite Industrial Products.
   c. Halliday Products.
   d. O'Keeffe's Inc.
   e. Precision Ladders, LLC.
   f. Royalite Manufacturing, Inc.
   g. Thompson Fabricating, LLC.

2. Space siderails *16 inches (406 mm)* apart unless otherwise indicated.

3. Siderails: Continuous extruded-aluminum channels or tubes, not less than *2-1/2 inches (64 mm)* deep, *3/4 inch (19 mm)* wide, and *1/8 inch (3.2 mm)* thick.

4. Rungs: Extruded-aluminum tubes, not less than *3/4 inch (19 mm)* deep and not less than *1/8 inch (3.2 mm)* thick, with ribbed tread surfaces.

5. Include safety cage by same material as ladder where osha required.

### 2.10 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

C. Galvanize exterior miscellaneous steel trim.

D. Prime exterior miscellaneous steel trim with zinc-rich primer. primer specified in Division 09 Section "High-Performance Coatings."

### 2.11 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 80 steel pipe.

B. All prime are to be galvanized.

### 2.12 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
2.13   LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.

B. Galvanize loose steel lintels located in exterior walls.

C. Prime loose steel lintels located in exterior walls with zinc-rich primer.

2.14   STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.15   FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

2.16   STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with universal shop primer unless zinc-rich primer is indicated.

C. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning." SSPC-SP 3, requirements indicated below:

3. Items Indicated to Receive Primers Specified in Division 09 Section "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Items: SSPC-SP 3, "Power Tool Cleaning."

D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLING METAL BOLLARDS

A. Anchor bollards in place with concrete footings. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

B. Fill bollards solidly with concrete, mounding top surface to shed water.

3.3 INSTALLING BEARING AND LEVELING PLATES


B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

C. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.
3.4  ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055000
SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Exterior Cladding Support System

1.2 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Aluminum extrusions for members and components of cladding system.

B. Shop Drawings: Show fabrication and installation details. [Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.] Provide Shop Drawings for the following:
   1. Exterior Cladding Support System

C. Delegated-Design Submittal: For exterior cladding support system, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.4 METALS


1.5 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
   1. Provide stainless-steel fasteners for fastening aluminum.
1.6 ALUMINUM FINISHES

A. As-Fabricated Finish: AA-M12.


PART 2 - EXECUTION

2.1 INSTALLATION, GENERAL

A. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Cast Aluminum: Heavy coat of bituminous paint.
2. Extruded Aluminum: Two coats of clear lacquer.

END OF SECTION 05 50 00
SECTION 06 10 00 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Rooftop equipment bases and support curbs.
   2. Wood blocking and nailers.
   3. Wood furring.
   4. Wood sleepers.
   5. Plywood backing panels.

1.2 RELATED SECTIONS

A. Section 018113 – Sustainability Requirements

1.3 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product.
   1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements
   2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. LEED Submittals:
   1. Certificates for Credit MR 7: Chain-of-custody certificates indicating that products specified to be made from certified wood comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
   2. Product Data for Credit IEQ 4.4: For composite wood products, documentation indicating that product contains no urea formaldehyde.
   3. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regionally manufactured and regionally extracted and manufactured materials. Include statement indicating cost for each regionally manufactured material.
      a. Include statement indicating location of manufacturer and distance to Project for each regionally manufactured material.
      b. Include statement indicating location of manufacturer and point of extraction, harvest, or recovery for each raw material used in regionally extracted and
manufactured materials. Indicate distance to Project and fraction by weight of each regionally manufactured material that is regionally extracted.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Certified Wood: Materials shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

B. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
3. Provide dressed lumber, S4S, unless otherwise indicated.

C. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat items indicated on Drawings, and the following:

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
4. Wood framing members that are less than 18 inches (460 mm) above the ground in crawls spaces or unexcavated areas.
5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.

2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

E. Application: Treat items indicated on Drawings, and the following:
   1. Concealed blocking.
   2. Roof construction.
   3. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

   1. Blocking.
   2. Nailers.
   3. Rooftop equipment bases and support curbs.
   5. Furring.

B. For items of dimension lumber size, provide Construction or No. 2 grade lumber of any species.

C. For concealed boards, provide lumber with 19 percent maximum moisture content and the following species and grades:
1. Mixed southern pine; No. 2 grade; SPIB.
2. Eastern softwoods; No. 2 Common grade; NeLMA.
3. Northern species; No. 2 Common grade; NLGA.
4. Western woods; Construction or No. 2 Common grade; WCLIB or WWPA.

2.5 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: DOC PS 1, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch (19-mm) nominal thickness.

1. Plywood shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.


C. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.

2.7 METAL FRAMING ANCHORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cleveland Steel Specialty Co.
2. KC Metals Products, Inc.
3. Phoenix Metal Products, Inc.
4. Simpson Strong-Tie Co., Inc.
5. USP Structural Connectors.

B. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those of products of manufacturers listed. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
   1. Use for interior locations unless otherwise indicated.

D. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A 653/A 653M; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 (Z550) coating designation; and not less than 0.036 inch (0.9 mm) thick.
   1. Use for wood-preservative-treated lumber and where indicated.

2.8 MISCELLANEOUS MATERIALS

A. Sill-Sealer Gaskets: Glass-fiber-resilient insulation, fabricated in strip form, for use as a sill sealer; 1-inch (25-mm) nominal thickness, compressible to 1/32 inch (0.8 mm); selected from manufacturer's standard widths to suit width of sill members indicated.

B. Sill-Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch (6.4 mm) thick, selected from manufacturer's standard widths to suit width of sill members indicated.

C. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.

B. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

C. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.

D. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.

E. Shear Wall Panels: Install shear wall panels to comply with manufacturer's written instructions.

F. Metal Framing Anchors: Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
G. Do not splice structural members between supports unless otherwise indicated.

H. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

I. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

J. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.
3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.

3.2 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 10 00
SECTION 061600 - SHEATHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Wall sheathing.
   2. Parapet sheathing.

1.2 RELATED SECTIONS

A. Section 018113 – Sustainability Requirements

1.3 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product.

B. Sustainable Design Submittals:
   2. Chain-of-Custody Qualification Data: For manufacturer and vendor.
   3. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
   4. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
   5. Product Data: For installation adhesives, indicating VOC content.
   6. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:
   1. Wood-preservative-treated plywood.
   2. Fire-retardant-treated plywood.
   3. Foam-plastic sheathing.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
B. **Vendor Qualifications:** A vendor that is certified for chain of custody by an FSC-accredited certification body.

**PART 2 - PRODUCTS**

**2.1 PERFORMANCE REQUIREMENTS**

A. **Fire-Resistance Ratings:** As tested according to ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

**2.2 WOOD PANEL PRODUCTS**

A. **Emissions:** Products shall meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. **Certified Wood:** The following wood products shall be certified as "FSC Pure" or "FSC Mixed Credit according to FSC STD-01-00 and FSC STD-40-004.

1. Plywood.
2. Oriented strand board.
3. Particleboard underlayment.
4. Hardboard underlayment.

**2.3 PRESERVATIVE-TREATED PLYWOOD**

A. **Preservative Treatment by Pressure Process:** AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.

B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

C. Application: Treat all plywood unless otherwise indicated

**2.4 FIRE-RETARDANT-TREATED PLYWOOD**

A. **General:** Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201/D 3201M at 92 percent relative humidity. Use where exterior type is not indicated.
3. Design Value Adjustment Factors: Treated lumber plywood shall be tested according to ASTM D 5516 and design value adjustment factors shall be calculated according to ASTM D 6305. Span ratings after treatment shall be not less than span ratings specified. For roof sheathing and where high-temperature fire-retardant treatment is indicated, span ratings for temperatures up to 170 deg F (76 deg C) shall be not less than span ratings specified.

C. Kiln-dry material after treatment to a maximum moisture content of 15 percent.

D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.

E. Application: Treat all plywood unless otherwise indicated

2.5 WALL SHEATHING

A. Glass-Mat Gypsum Sheathing: ASTM C 1177/1177M.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. CertainTeed Corporation.
   b. Georgia-Pacific Building Products.
   c. National Gypsum Company.
   d. Temple-Inland Building Products by Georgia-Pacific.
   e. United States Gypsum Company.

2. Type and Thickness: Type X, 5/8 inch (15.9 mm) thick.

B. Extruded-Polystyrene-Foam Sheathing: ASTM C 578, Type IV, in manufacturer's standard lengths and widths with tongue-and-groove or shiplap long edges as standard with manufacturer.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. DiversiFoam Products.
b. Dow Chemical Company (The).
c. Kingspan Insulation.
d. Owens Corning.

2. Thickness: 1 inch (25 mm) sheets – refer to drawings for total thickness requirements.
3. Flame Propagation Test: Materials and construction shall be as tested according to NFPA 285.

2.6 PARAPET SHEATHING

A. Plywood Sheathing: Exposure 1, Structural I sheathing.

B. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   1. For roof parapet and wall sheathing, provide fasteners with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.

C. ALL above roof sheathing is to be plywood as noted above.

2.7 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

A. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C 834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.
   1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches (50 mm) wide, 10 by 10 or 10 by 20 threads/inch (390 by 390 or 390 by 780 threads/m), of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

B. Sheathing Tape for Foam-Plastic Sheathing: Pressure-sensitive plastic tape recommended by sheathing manufacturer for sealing joints and penetrations in sheathing.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
C. Securely attach to substrate by fastening as indicated, complying with the following:
   1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
   2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2),
      "Alternate Attachments," in the ICC's International Residential Code for One- and Two-
      Family Dwellings.
   3. ICC-ES evaluation report for fastener.

D. Coordinate wall, parapet and roof sheathing installation with flashing and joint-sealant
   installation so these materials are installed in sequence and manner that prevent exterior
   moisture from passing through completed assembly.

E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of
   structural support elements.

3.2 GYPSUM SHEATHING INSTALLATION

A. Comply with GA-253 and with manufacturer's written instructions.
   1. Fasten gypsum sheathing to wood framing with nails or screws.
   2. Fasten gypsum sheathing to cold-formed metal framing with screws.
   3. Install panels with a 3/8-inch (9.5-mm) gap where non-load-bearing construction abuts
      structural elements.
   4. Install panels with a 1/4-inch (6.4-mm) gap where they abut masonry or similar materials
      that might retain moisture, to prevent wicking.

B. Seal sheathing joints according to sheathing manufacturer's written instructions.
   1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount
      of sealant to completely cover joints and fasteners after troweling. Seal other penetrations
      and openings.
   2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and
      trowel sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners
      with a trowel so fasteners are completely covered. Seal other penetrations and openings.

3.3 FOAM-PLASTIC SHEATHING INSTALLATION

A. Comply with manufacturer's written instructions.

B. Foam-Plastic Wall Sheathing: Install vapor-relief strips or equivalent for permitting escape of
   moisture vapor that otherwise would be trapped in stud cavity behind sheathing.

C. Apply sheathing tape to joints between foam-plastic sheathing panels and at items penetrating
   sheathing. Apply at upstanding flashing to overlap both flashing and sheathing.

END OF SECTION 061600
SECTION 062023 - INTERIOR FINISH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Shelving

B. Related Requirements:
   1. Section 099123 "Interior Painting" for priming and backpriming of interior finish carpentry.
   2. Section 018113 – Sustainability Requirements

1.2 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product.

B. Sustainable Design Submittals:
   1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
   3. Chain-of-Custody Qualification Data: For manufacturer and vendor.
   4. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
   5. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
   6. Product Data: For installation adhesives, indicating VOC content.
   7. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.

C. Samples: For each type of paneling.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.
PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Regional Materials: wood products shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.

B. Regional Materials: wood products shall be manufactured within 500 miles (800 km) of Project site.

C. Certified Wood: wood products shall be certified as "FSC Pure"[ or "FSC Mixed Credit"] according to FSC STD-01-00 and FSC STD-40-004.

D. Composite Wood Products: Products shall be made without urea formaldehyde.

E. Composite Wood Products: Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Lumber: DOC PS 20.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber, mark grade stamp on end or back of each piece

G. Softwood Plywood: DOC PS 1.

H. Hardboard: ANSI A135.4.

I. MDF: ANSI A208.2, Grade 130

J. Particleboard: ANSI A208.1, Grade M-2

K. Melamine-Faced Particleboard: Particleboard complying with ANSI A208.1, Grade M-2, finished on both faces with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD3, Grade VGL, for test methods 3.3, 3.4, 3.6, 3.8, and 3.10.

1. Color: White

2.2 FIRE-RETARDANT-TREATED MATERIALS

A. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.

B. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

1. For exposed lumber and plywood indicated to receive a stained or natural finish, mark back of each piece.

C. Application: Where indicated

2.3 SHELVING AND CLOTHES RODS

A. Exposed Shelving: Made from the following material 3/4 inch (19 mm) thick.

1. Melamine-faced particleboard with applied-PVC front edge.

B. Shelf Cleats: 3/4-by-5-1/2-inch (19-by-140-mm) boards, as specified above for shelving

C. Shelf Brackets with Rod Support: BHMA A156.16, B04051; prime-painted formed steel.

D. Shelf Brackets without Rod Support: BHMA A156.16, B04041; prime-painted formed steel.

2.4 MISCELLANEOUS MATERIALS

A. Low-Emitting Materials: Adhesives shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.

1. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Multipurpose Construction Adhesive: Formulation complying with ASTM D 3498 that is recommended for indicated use by adhesive manufacturer.

1. Adhesives shall have a VOC content of 70g/L or less.
PART 3 - EXECUTION

3.1 PREPARATION

A. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours unless longer conditioning is recommended by manufacturer.

3.2 INSTALLATION, GENERAL

A. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.

1. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
2. Where face fastening is unavoidable, countersink fasteners, fill surface flush, and sand unless otherwise indicated.
3. Install to tolerance of 1/8 inch in 96 inches (3 mm in 2438 mm) for level and plumb. Install adjoining interior finish carpentry with 1/32-inch (0.8-mm) maximum offset for flush installation and 1/16-inch (1.5-mm) maximum offset for reveal installation.
4. Install stairs with no more than 3/16-inch (4.7-mm) variation between adjacent treads and risers and with no more than 3/8-inch (9.5-mm) variation between largest and smallest treads and risers within each flight.

3.3 SHELVING AND CLOTHES ROD INSTALLATION

A. Cut shelf cleats at ends of shelves about 1/2 inch (13 mm) less than width of shelves and sand exposed ends smooth.

B. Install shelf cleats by fastening to framing or backing with finish nails or trim screws, set below face and filled. Space fasteners not more than 16 inches (400 mm) o.c.

C. Install shelf brackets according to manufacturer's written instructions, spaced not more than [32 inches (800 mm)] [36 inches (900 mm)] o.c. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.

D. Cut shelves to neatly fit openings with only enough gap to allow shelves to be removed and reinstalled. Install shelves, fully seated on cleats, brackets, and supports.

END OF SECTION 062023
SECTION 064219 – MINERAL PROFILE PANELING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Lightweight composite mineral profile paneling and seam finishing materials to create a monolithic sculptured wall surface.

1.2 ACTION SUBMITTALS

A. Product Data: Each product specified.

B. Project List: Minimum 5 previous completed installations of similar material and complexity. Include contact name and email address or telephone number for each project.

C. Shop Drawings: Show standard and project specific details including termination at adjacent surfaces.

D. Samples: Minimum 15 by 15 inch panel of specified designs.

INFORMATIONAL SUBMITTALS

E. Manufacturer’s installation instructions.

F. Regulatory agency sustainability submittals:

G. Qualification Statements: Proof of manufacturer, installer, and finisher qualifications.

1.3 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:

B. Qualifications:
   1. Manufacturer: Minimum five years experience in producing mineral profile paneling.
   2. Installer: Minimum three years experience in finish carpentry/architectural woodwork installation.
   3. Finisher: Minimum three years experience in executing Level 5 finish in accordance with GA-214
1.4 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements:
   1. Store panels in fully enclosed space, protected against damage from moisture, direct sunlight, and surface contamination.
   2. Store panels vertically, in shipping crates, until ready to be installed. Loosen crate lids to allow for venting. Do not stack or lean against walls.
   3. Store panels in area of installation minimum 24 hours prior to installation.

B. Packaging Waste Management: 100 percent of materials used to package components of this section shall be recyclable.

1.5 FIELD CONDITIONS

A. Ambient Conditions:
   1. HVAC: Operate HVAC system to maintain occupancy level temperature and relative humidity conditions (35 to 67 percent) in the area of installation from 24 hours prior to delivery of panels to the installation area through remainder of construction period.
   2. Lighting: Permanent project lighting, including any special lighting used to highlight the profiled panels, must be operational prior to seam finishing.

1.6 WARRANTY

A. Manufacturer Warranty: Provide manufacturer’s standard limited warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Basis-of-Design – Modular Arts, Inc

2.2 COMPONENTS

A. Profile Panel: Smooth surface mineral composite panel with lightweight plant-based foam back.
   1. Size: 32 by 32 by 1.5 inch maximum profile relief.
   2. Physical Properties:
      a. Izod Impact Strength: ASTM D 256 16 in*lbs
      b. Thermal Expansion: ASTM D 696 3.8x10^-7 in/in °F.
      c. Compressive Strength: ASTM D 696 2.3 ksi.
      d. Flame Spread Index: ASTM E 84 0
      e. Smoke Development Index: ASTM E 84 50
      f. Weight (for all designs excluding YUMA) 1.5 psf
      g. Weight (for YUMA design only) 3 psf
3. Panel Design **MP-1**
   a. Cliff Panel – Vertical Installation

### 2.3 ACCESSORIES

A. Anchors: 30 lb self-drilling, drywall anchor.

B. Screws: Coarse thread, drywall type, length as required by panel design and in accordance with Manufacturer’s Installation Instructions.

### 2.4 SOURCE QUALITY CONTROL

A. Fabrication Tolerances:
   1. Dimension, length and width ±± 1/16 inch
   2. Thickness: ±± 1/16 inch
   3. Weight: ±± 1/16 inch

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

A. Examine substrates upon which profile paneling will be installed.
   1. Verify that substrate is a material listed as an acceptable substrate by the profile paneling manufacturer.

B. Verify that permanent project lighting is in place and operational prior to start of seam finishing.

C. Coordinate with responsible entity to correct unsatisfactory conditions.

D. Commencement of work by installer is acceptance of substrate conditions.

#### 3.2 INSTALLATION

A. Install profile paneling in accordance with Manufacturer’s Installation Instructions except that seam finishing shall be performed under Section 09 29 00-Gypsum Board, and sealing and painting shall be performed under Section 09 91 23-Interior Painting

#### 3.3 CLEANING

A. Waste Management: Refer to Section 01 74 00 – Cleaning and Waste Management.

#### 3.4 PROTECTION

A. Protect finished work from damage during remainder of construction period.
END OF SECTION 062614
SECTION 064100 - ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES
   A. Plastic Laminate cabinets.
   B. Slatwall Display Panels
   C. Wood Ceilings
   D. Wood Cased Beams

1.3 RELATED SECTIONS
   A. Section 062000 – Finish Carpentry
   B. Section 123661 – Simulated Stone Countertops (and sills)
   C. Section 018113 – Sustainability Requirements

1.4 DEFINITIONS
   A. Exposed surfaces include all surfaces visible when:
      1. Drawers and opaque doors (if any) are closed.
      2. Areas behind clear glass doors.
      3. Bottoms of cabinets 42-inches or more above finished floor.
      4. Top of cabinets below 78-inches above finished floor.
   B. Semi-exposed surfaces include the following:
      1. Open opaque doors or extended drawers.
      2. Bottoms of cabinets that are more than 30-inches and less than 42-inches above finished floor.
   C. Concealed surfaces include the following:
      1. Surfaces not visible after installation.
      2. Bottoms of cabinets less than 30-inches above finished floor.
      3. Tops of cabinets over 78-inches above finish floor and not visible from an upper level.
      4. Stretchers, blocking, and components concealed by drawers.
1.5 SUBMITTALS

A. Product Data: For each type of product indicated, including cabinet hardware and accessories and finishing materials and processes.

B. Shop Drawings: Submit shop drawings for each item of architectural woodwork. Indicate dimensions, details of construction, finishes, and hardware.
   1. Show details full size.
   2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.

C. Samples for Verification:
   1. Plastic laminates, 8 by 10 inches (200 by 250 mm), for each type, color, pattern, and surface finish, with 1 sample applied to core material and specified edge material applied to 1 edge.
   2. Solid-surfacing materials, 6-inches square.
   3. Thermoset decorative-panels, 8 by 10 inches (200 by 250 mm), for each type, color, pattern, and surface finish, with edge banding on 1 edge.
   4. Slatwall finish material

D. Woodwork Quality Standard Compliance Certificates: WI-certified compliance certificates.

1.6 QUALITY CONTROL

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production of interior architectural woodwork with sequence-matched wood veneers.

C. Forest Certification: Provide components made with a minimum of 50% of wood products obtained from forests certified by an FSC-accredited certification body.

D. AWS Quality Standard: Comply with the specified grade(s) of interior architectural woodwork indicated for construction, finishes, and installation, specified section(s), and applicable requirements of the current edition of the "Architectural Woodwork Standards" by AWI and WI.
   1. Provide WI-certified compliance labels and certificates indicating that woodwork, including installation, complies with requirements of grades specified.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.
1.8 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Local/Regional Materials: Give preference to manufacturer’s whose facilities are within a 500 mile radius of the project site. Also give preference to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

B. Certified Wood: Use wood obtained from forests certified by an FSC accredited certification body.

C. VOC Content: Adhesives, sealants, paints, welding, and coatings applied on-site on the interior of the building and products used on the interior of the building shall comply with VOC limits below.
   1. Use materials that have the minimum VOC content in units of g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Composite Wood and Agrifiber: Use only composite wood and agrifiber products free of urea formaldehyde resin binders.

2.2 MATERIALS

A. General: Provide materials that comply with requirements of WI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.

B. Wood Species for Opaque Finish: Any closed-grain hardwood.

C. Hardwood and Softwood Lumber: Custom graded in accordance with WI; average moisture content of 8 percent.

D. Hardwood Plywood: ANSI/HPMA HP; graded in accordance with WI, veneer core material; type of glue recommended for application, and containing no urea formaldehyde.
   1. Formaldehyde Emission Levels: Comply with formaldehyde emission requirements of HPMA FE for hardwood plywood.

E. MDF: ANSI A208.2, Grade 130, made with binder containing no urea-formaldehyde resin.

F. Wood Particleboard: ANSI A208.1, Grade M-2 composed of wood chips, medium density, made with high waterproof resin binders; of grade to suit application; sanded faces, made with binder containing no urea-formaldehyde resin.
G. Cabinet Interiors, Shelves, and Counter Substrate: 3/4-inch Medite II, interior grade wood-based composite panels manufactured from softwood fibers with minimum 90% pre-consumer recycled wood combined with formaldehyde-free synthetic resin, with clear sealer.

H. Quartz Surfacing:
   1. Quartz Surfacing Composition: 93 percent crushed quartz aggregate combined with resins and pigments and fabricated into slabs.
      a. Basis-of-Design Product: Silestone USA.
      b. Color: To be selected by Architect.
   2. Dimensions:
      a. Thickness: As shown on Drawings.
      b. Slabs Size: Not less than 56.5 x 120 inches (1.44 x 3.05 m) to minimize number of joints in installation.
   3. Identification: Label material with batch number by imprinting on back with manufacturer’s identifying mark.

I. Plastic Laminate:
   1. High-pressure decorative laminate complying with NEMA LD 3.
   3. Provide from one of the following:
      a. Formica.
      b. Nevamar.
      c. Wilsonart.
      d. Substitutions: Under provisions of Division 01.

J. Thermoset Decorative Panels (Melamine): Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.
   1. Provide PVC or polyester edge banding complying with LMA EDG-1 on components with exposed or semiexposed edges.
   2. Color: White, unless indicated otherwise on Drawings.

K. Edge Banding for Plastic Laminate Shelves: Vinyl, complying with LMA EDG-1, 3 mm thick material, with radius edges, color and finish to match laminate exactly.

L. Adhesive:
   1. FS MMM-A-130 contact adhesive; type recommended by laminate manufacturer to suit application.
   2. VOC Limits for Installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
      a. Wood Glues: 30 g/L.
      b. Contact Adhesive: 250 g/L.

M. Adhesive for Bonding Plastic Laminate: Unpigmented contact cement.
   1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.
N. Bolts, Nuts, Washers, Lags, Pins, Fasteners, and Screws: Of size and type to suit application.

2.3 PLASTIC LAMINATE CABINET FABRICATION

A. AWS Construction:
   1. Grade: Custom.
   2. Type: Type II single-length sections to fit across openings.
   3. Cabinet Style: Style A Frameless.

B. Countertop Support: 3/4-inch plywood.

C. Edge Material: Same as cladding on faces.

D. Cabinet Hardware: ANSI/BHMA A156.9, see schedule at end of this Section.

E. Colors, Patterns, and Finishes: To be selected from manufacturer’s full range of available colors.

2.4 SLATWALL DISPLAY PANELS

A. General: Slatwall merchandising and display panels for primary use as perimeter wall or floor fixturing in retail, merchandising and display applications

B. Materials
   1. Slatwall display panels: MDF (medium density fiberboard) with cut grooves to accept standard slatwall accessories for merchandising displays.
      a. Standard display panels: ¾”x48”x96” +/-0.0625: on squareness or +/- 0.125 as measured diagonally across the boards.
      b. Board properties: 48lb density with an internal bond strength of 110 lbs per square inch. MDF has a linear expansion of .30% and a moisture content of 6-8%. The screw holding capacity for the face of 350 lbs and 275 lbs for the edge.
      c. Grove spacing: 4” o.c.
      d. Surface finish: Maple wood veneer, rotary cut in a .035” thickness. Stain grade.
      e. Grove finish: Mill aluminum inserts.

2.5 WOOD CEILINGS

A. General: Prefinished wood flooring installed on ceiling. Coordinate final installation method with manufacturer’s recommendations

B. ¾” x 5” or ¾”x 3 ¾” board size. Prefinished. Clear Grade wood. Red finish.

C. Tongue and groove installation with matching prefinished trims.

D. Install in 12”-72” random length patterns. Conceal nail and construction adhesive to substrate.
E. Approved Manufacturers
1. Bellawood
2. Hurst Hardwoods
3. Unique Wood Floors
4. Nature Flooring

F. Finish intended to match the exterior wood as close as possible. Final color to be selected by architect from full range of manufacturers options.

G. Provide additional trim as required matching the ceiling finish and color.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify adequacy of backing and support framing.

B. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.

C. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.2 INSTALLATION, GENERAL

A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.

B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.

C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).

D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.

3.3 CABINET INSTALLATION

A. Install woodwork to comply with WI Section 26 for same grade specified in Part 2 of this section for type of woodwork involved.
B. Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
   1. Install cabinets with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
   2. Maintain veneer sequence matching of cabinets with transparent finish.
   3. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches (400 mm) oc with No. 10 wafer-head screws sized for 1-inch (25-mm) penetration into wood framing, blocking, or hanging strips.

C. Countertops: Anchor securely to base units.
   1. Align adjacent stone countertops and form seams handtight to minimize joints using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

D. Use concealed joint fasteners to align and secure adjoining cabinet units.

E. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose.

F. Secure cabinet bases to floor using appropriate anchorages. Permanently fix countertops to wall using appropriate angles.

G. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

H. Clean casework, counters, shelves, hardware, fittings and fixtures.

I. Upon completion of installation, clean all installed items. Remove pencil and ink marks from surfaces. Leave area of work broom clean.

J. Protect casework after installation; do not permit other trades to use casework as footstools or ladders to perform their work.

3.4 COUNTERTOP INSTALLATION

A. Install woodwork to comply with WI Section 16 for same grade specified in Part 2 of this section for type of woodwork involved.

B. Permanently fix countertops to wall using appropriate angles. Secure countertops in place, square, plumb and level.

C. Carefully scribe countertops abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose. Caulking not to exceed 1/16 inch in width.

D. Equipment cut-outs indicated on plans within countertops shall be cut by countertop installer.
E. Mechanical fasteners are not allowed at exposed surfaces.

F. Upon completion of installation, clean all installed items. Remove pencil and ink marks from surfaces. Leave area of work broom clean.

G. Protect countertops after installation; do not allow other trades to use countertops as footstools or ladders to perform their work.

3.5 WOOD CEILING INSTALLATION

A. Prior to installation, review direction and layout with Architect and Construction Manager.

B. Install plumb and level

C. Use hidden fasteners as recommended by manufacturer.

D. Install perimeter trim fully as shown on the drawings

E. Fill and blend any fastener holes to match prefinished finish.

3.6 ADJUSTING AND CLEANING

A. Construction Waste Management: Manage construction waste in accordance with provisions of Division 1 Section ‘Construction Waste Management’. Submit documentation for Credit MR 2.1 and MR 2.2 to satisfy the requirements of that Section.

B. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

C. Clean, lubricate, and adjust hardware.

D. Clean woodwork on exposed and semieixed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

3.7 CABINET HARDWARE SCHEDULE

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Section 08710. Where manufacturer's name or product number is not indicated provide best quality commercially available cabinet hardware.

B. Cabinet Shelf Standards and Rests: BHMA A156.9, all components metal, B04071; with shelf rests, B04081:
   1. Bracket: KV 187, with 200 series end, center and front rests for anchoring shelf to bracket.
   2. Heavy-Duty Standards: KV 255, with 256 closed shelf rest.
   3. Cabinet Rests: KV 331; shelf rest - 3/8" (9mm) W x 1/2" (13mm) L.

C. Adjustable Shelf Clips: BHMA A156.9, B04013:
1. KV 346, use with 3/8-inch drilled holes and #129 rubber cushion.

D. Heavy Weight Drawer Slides: BHMA A156.9, B05091:
   1. KV 8805.
   2. Accuride 3640.
   3. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-overtravel-extension type; zinc-plated steel ball-bearing slides.
   4. Full extension slides with 1-inch overtravel, side-mount, 200 pound capacity.

E. Drawer and Door Pulls: Style as selected by Owner. Acceptable manufacturers include the following:
   1. Trimeco/Builder Brass Works/Quality.
   2. Ives, An Ingersoll-Rand Business.
   4. Wire Pulls: Back mounted, solid metal, 4 inches (100 mm) long, 5/16 inch (8 mm) in diameter, and 5/16 inch (8 mm) in diameter.

F. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602,
   1. Blum 97M558.
   2. 135 degrees of opening, self-closing.
   3. Provide three hinges for doors over 48 inches in height.

G. Magnetic Catches: Magnetic catches, BHMA A156.9, B03141
   1. Ives, An Ingersoll-Rand Business, 325 on single doors.
   2. Ives, An Ingersoll-Rand Business, 326 on double doors.

H. Cabinet, Sliding Door, and Drawer Locks:
   2. Door Locks: BHMA A156.11, E07121.
   3. Drawer Locks: BHMA A156.11, E07041.

I. Mailbox Shelf Labels: Provide one of the following, or equal:
   1. Type: Clip-on shelf label holders, 1" x 5" including blank white labels as manufactured by Library Supplies & Furnishings #44-475-001, black, 3-1/4" x 7-3/4" x 1-1/2", with blank labels and clear covers in white, #44-476-001,
   2. Type: Self-adhesive holders, 3/8" high holders cut to 5" length, with white labels as manufactured by Holdex.
   3. Provide 50 percent more quantity than number of mailbox shelves shown on Drawings.

J. Drawer Edging:
   1. File Folder Support:
      a. Vertical Files: Hafele, "File Drawer Folder Hanging Rail", #422.71.901, satin silver finish, or equal, no known (metal) equal. Note that the width of the drawer box is very specific to letter size files; fabricate the width of the file drawer units sized to handle files without wasted width.
      b. Drawer Protection Edge: 18 gage, #304 brushed stainless steel finish as shown on Drawings.
K. Grommets for Cable Passage through Countertops: 2-inch (51-mm) OD, black, molded-plastic grommets and matching plastic caps with slot for wire passage.

L. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
   1. Satin Stainless Steel: BHMA 630.

END OF SECTION 064100
SECTION 07 19 00 - WATER REPELLENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All provisions of the Contract Documents apply to this Section. The Contractor for this Section shall be responsible for complete familiarity with same.

B. Related Sections:
   1. Section 04 20 00 Unit Masonry
   2. Section 018113 – Sustainability Requirements

1.2 SUMMARY

A. This Section includes penetrating water-repellent coatings for the following vertical and horizontal surfaces:
   1. All surfaces noted on the drawings as being Masonry Veneer.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product test reports.

C. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Applicator agree(s) to repair or replace materials that fail to maintain water repellency within Ten (10) years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

B. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.2 PENETRATING WATER REPELLENTS

A. Siloxane, Penetrating Water Repellent: Clear, oligomeric alkylalkoxyasiloxanes containing 10 percent or more solids; with alcohol, ethanol, mineral spirits, water, or other proprietary solvent carrier; and with 3.3 lb/gal. (400 g/L) or less of VOCs.

1. Available Products:
   a. ChemMasters; Spall Guard WB, Spall Guard WB 10%.
   b. Chemprobe Coating Systems, L. P.; Prime A Pell H2O.
   c. Diedrich Technologies, Inc.; 303-S.
   d. Euclid Chemical Company (The); Weatherguard.
   e. Hydrozo, a division of ChemRex; Enviroseal 40.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrate of substances that might interfere with penetration or performance of water repellents. Test for moisture content, according to water-repellent manufacturer's written instructions, to ensure that surface is dry enough.

1. Masonry Veneer (includes Concrete Masonry Units and Face Brick) and Cast Stone: Remove all substances that could prevent adhesion or penetration of water repellents.

B. Test for pH level, according to water-repellent manufacturer's written instructions, to ensure chemical bond to silicate minerals.

C. Protect adjoining work, including sealant bond surfaces, from spillage or blow-over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live plants and grass.

D. Coordination with Sealants: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.
1. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those used in the work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

A. All existing and new exterior masonry shall receive waterproofing.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect the substrate before application of water repellent and to instruct Applicator on the product and application method to be used.

C. Apply a heavy-saturation spray coating of water repellent on surfaces indicated for treatment using low-pressure spray equipment. Comply with manufacturer's written instructions for using airless spraying procedure, unless otherwise indicated.

   1. Cast Stone: At Contractor's option, first application of water repellent on precast concrete units may be completed before installing units. Mask sealant-bond surfaces to prevent water repellent from migrating onto joint surfaces. Notify the Architect in advance if this option will be implemented.

D. Apply a second saturation spray coating, repeating first application. Comply with manufacturer's written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult manufacturer's technical representative if written instructions are not applicable to Project conditions.

3.3 CLEANING

A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application as work progresses. Repair damage caused by water-repellent application. Comply with manufacturer's written cleaning instructions.

END OF SECTION 07 19 00
SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes qualitative requirements for organic inorganic applied for thermal protection at following:
   1. Perimeter insulation under slabs-on-grade (where indicated on the drawings).
   2. Perimeter wall insulation (supporting backfill).
   3. Cavity-wall insulation.
   5. Sound attenuation insulation.

B. Related Sections
   1. Section 018113 – Sustainability Requirements

1.2 PERFORMANCE REQUIREMENTS

A. Plenum Rating: Provide glass fiber insulation where indicated in ceiling plenums whose test performance is rated as follows for use in plenums as determined by testing identical products per "Erosion Test" and "Mold Growth and Humidity Test" described in UL 181, or on comparable tests from another standard acceptable to authorities having jurisdiction.
   1. Erosion Test Results: Insulation shows no visible evidence of cracking, flaking, peeling, or delamination of interior surface of duct assembly, after testing for 4 hours at 2500-fpm (13-m/s) air velocity.
   2. Mold Growth and Humidity Test Results: Insulation shows no evidence of mold growth, delamination, or other deterioration due to the effects of high humidity, after inoculation with Chaetomium globosium on all surfaces and storing for 60 days at 100 percent relative humidity in the dark.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's specifications, installation, instructions, general recommendations, and Material Safety Data Sheets for water repellents. Include data substantiating that the materials are recommended for the intended application by the manufacturer. These submittals shall:
   1. For each element of the work that meets the specified requirements of the work, without exception, the submission is for general information only.

B. For any element of the work that varies, in any way, from the specified requirements of the work, Contractor shall highlight the extent of variance on the submittal. Architect’s review shall be limited to the variance as highlighted.
C. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and pre-consumer recycled content.
      a. Include statement indicating costs for each product having recycled content.

1.4 QUALITY ASSURANCE

A. Retain ASTM test method below based on product and kind of fire-resistance characteristic specified for each product in Part 2. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84 for surface-burning characteristics and other methods indicated with product, by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 FOAM-PLASTIC BOARD INSULATION (RIGID)

A. Extruded Polystyrene Board Insulation: Rigid, cellular polystyrene thermal insulation formed from polystyrene base resin by an extrusion process, using hydrochlorofluorocarbons as blowing agents to comply with ASTM C578 for type and with other requirements indicated below:
   1. Type IV, 1.60 pounds/cu.ft. minimum density.
   2. Application:
      a. Insulation under slabs on grade.
      b. Foundation wall insulation.
   3. Type X, 1.35 pounds/cu.ft. minimum density.
   4. Application:
      a. Exterior Wall Panel Insulation.
   5. With maximum flame-spread and smoke-developed indexes of 75 and 450, respectively.
   6. List of manufacturers:
      a. Dow Chemical Company
      b. Owens Corning
      c. Pactiv (Green Guard)

2.3 GLASS-FIBER BLANKET INSULATION

A. Available Manufacturers:
1. Owens Corning
2. Thermafiber
3. Johns Manville
4. Certain Teed Corp.
5. Knauf Fiber Glass

B. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
   1. Mineral Fiber Type: Fibers manufactured from glass.
   2. Surface Burning Characteristics: Maximum flame spread and smoke developed valves of 25 and 50.
   3. Application: Concealed building insulation.

C. Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type III (blankets with reflective membrane facing), Class A (membrane-faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil-scrim-kraft, FRK vapor-retarder membrane on 1 face.
   1. Provide glass-fiber blanket insulation at all locations, unless notes otherwise on the drawings.

D. Where glass-fiber blanket insulation is indicated by the following thicknesses, provide blankets in batt or roll form with thermal resistances indicated:
   1. 3-1/2 inches thick; R = 11.0
   2. 6-1/4 inches thick; R = 19.0
   3. 9-1/2 inches thick; R = 30.0
   4. Provide insulation full depth of cavity / space to be insulated, unless noted otherwise.

2.4 SOUND ATTENTION BLANKETS

A. Unfaced, Slag-Wool-Fiber/Rock-Wool-Fiber Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

B. Where Sound Attenuation Blankets (slag-wool-fiber/rock-wool-fiber blanket insulation) is indicated on the Drawings, the thickness of the insulation shall be full depth of stud space or the cavity / space to be insulated, unless noted otherwise.

C. Available Manufacturers:
   1. Thermafiber.
   2. Fibrex Insulations Inc.
   3. Owens Corning.

2.5 AUXILIARY INSULATING MATERIALS

A. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.
2.6 VAPOR RETARDER

B. A. 6 mil polythene.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice, rain, and snow.

C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Water-Piping Coordination: If water piping is located within insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.

E. For preformed insulating units, provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

F. All materials herein specified shall be installed complete, without voids or gaps, attached securely and permanently in place. Install behind electrical outlets. Tape all splice joints.

G. Install rigid insulation board continuous with tight fit at all joints.

H. Install safing insulation of proper size with methods as approved by the manufacturer. Furnish safing clips and other accessories required for a complete installation. Compress and install in all expansion joints, and all other openings to seal around telephone conduit, pipes, ducts and other utilities.

I. Use mineral fiber blankets or cellular glass insulation around exterior door frames, windows, door soffits and other voids occurring in building construction.

3.2 INSTALLATION OF PERIMETER AND UNDER-SLAB INSULATION

A. On vertical surfaces, set insulation units in adhesive applied according to manufacturer's written instructions. Use adhesive recommended by insulation manufacturer.

1. If not otherwise indicated, extend insulation a minimum of 24 inches (610 mm) below exterior grade line.
B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

C. 1. If not otherwise indicated, extend insulation a minimum of 24 inches (610 mm) from interior face of foundation wall.

D. Protect below-grade insulation on vertical surfaces from damage during backfilling by applying protection course with joints butted. Set in adhesive according to insulation manufacturer's written instructions.

E. Protect top surface of horizontal insulation from damage during concrete work by applying protection course with joints butted.

3.3 INSTALLATION OF CAVITY-WALL INSULATION

A. On units of foam-plastic board insulation, install pads of adhesive spaced approximately 24 inches (610 mm) o.c. both ways on inside face, and as recommended by manufacturer. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates indicated.

1. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Division 04 Section "Unit Masonry."

3.4 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Seal joints between foam-plastic insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.

C. Set vapor-retarder-faced units with vapor retarder to warm-in-winter side of construction, unless otherwise indicated.

1. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure airtight installation.

D. Install mineral-fiber insulation in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill cavity, provide lengths that will produce a snug fit between ends.

2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.

3. For metal-framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
E. Install board insulation in curtain-wall construction where indicated on Drawings according to curtain-wall manufacturer's written instructions.
   1. Retain insulation in place by metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated between insulation and glass.
   2. Install insulation where it contacts perimeter fire-containment system to prevent insulation from bowing under pressure from perimeter fire-containment system.

F. Stuff unfaced slag–wool–fiber / rock-wool-blanket insulation into miscellaneous voids and cavity spaces where shown. Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft. (40 kg/cu. m).

END OF SECTION 072100
SECTION 072500 - WEATHER BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Building wrap.
   2. Flexible flashing.

B. Related Sections
   1. 018113 – Sustainability Requirements

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For water-resistive barrier and flexible flashing, from ICC-ES.

PART 2 - PRODUCTS

2.1 WEATHER-RESISTIVE BARRIER

A. Building Wrap: ASTM E 1677, Type I air barrier; with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested according to ASTM E 84; UV stabilized; and acceptable to authorities having jurisdiction.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Chemical Company (The); Styrofoam Weathermate Plus Brand Housewrap.
   b. DuPont (E. I. du Pont de Nemours and Company); Tyvek CommercialWrap
   c. Ludlow Coated Products; Barricade Building Wrap.
   d. Pactiv, Inc.; GreenGuard [Ultra Wrap
   e. Raven Industries Inc.; Fortress Pro Weather Protective Barrier.

2. Water-Vapor Permeance: Not less than 50g through 1 sq. m of surface in 24 hours per ASTM E 96/E 96M, Desiccant Method (Procedure A).

B. Building-Wrap Tape: Pressure-sensitive plastic tape recommended by building-wrap manufacturer for sealing joints and penetrations in building wrap.
2.2 MISCELLANEOUS MATERIALS

A. Flexible Flashing: Self-adhesive butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

1. Products: Subject to compliance with requirements, provide one of the following

   a. DuPont (E. I. du Pont de Nemours and Company); DuPont Flashing Tape.
   c. Proteco Wrap Company; BT-25 XL.
   d. Raven Industries Inc.; Fortress Flashshield.
   e. Advanced Building Products Inc.; Wind-o-wrap.
   f. Carlisle Coatings & Waterproofing; CCW-705-TWF Thru-Wall Flashing.
   g. Fiberweb, Clark Hammerbeam Corp.; Aquaflash 500.
   h. Fortifiber Building Systems Group; Fortiflash 40.
   j. MFM Building Products Corp.; Window Wrap.
   k. Polyguard Products, Inc.; Polyguard JT-30 Tape.
   l. Sandell Manufacturing Co., Inc.; Presto-Seal.

PART 3 - EXECUTION

3.1 WATER-RESISTIVE BARRIER INSTALLATION

A. Cover sheathing with water-resistive barrier as follows:

   1. Cut back barrier 1/2 inch (13 mm) on each side of the break in supporting members at expansion- or control-joint locations.
   2. Apply barrier to cover vertical flashing with a minimum 4-inch (100-mm) overlap unless otherwise indicated.

B. Building Paper: Apply horizontally with a 2-inch (50-mm) overlap and a 6-inch (150-mm) end lap; fasten to sheathing with galvanized staples or roofing nails.

C. Building Wrap: Comply with manufacturer's written instructions.

   1. Seal seams, edges, fasteners, and penetrations with tape.
   2. Extend into jambs of openings and seal corners with tape.

3.2 FLEXIBLE FLASHING INSTALLATION

A. Apply flexible flashing where indicated to comply with manufacturer's written instructions.
1. Lap seams and junctures with other materials at least 4 inches (100 mm) except that at flashing flanges of other construction, laps need not exceed flange width.
2. Lap flashing over water-resistive barrier at bottom and sides of openings.
3. Lap water-resistive barrier over flashing at heads of openings.

END OF SECTION 072500
SECTION 072726 - FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes fluid-applied, vapor-permeable membrane air barriers.

1.2 PREINSTALLATION MEETINGS
   A. Preinstallation Conference: Conduct conference at Project site

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Sustainable Design Submittals:
      1. Product Data: For coatings, indicating VOC content.
      2. Laboratory Test Reports: For coatings, indicating compliance with requirements for low-emitting materials.
   C. Shop Drawings: For air-barrier assemblies.
      1. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.

1.4 INFORMATIONAL SUBMITTALS
   A. Product certificates.
   B. Product test reports.

1.5 QUALITY ASSURANCE
   A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. **VOC Content:** 250g/L or less.

B. **Low-Emitting Materials:** Products shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.2 PERFORMANCE REQUIREMENTS

A. **General:** Air barrier shall be capable of performing as a continuous vapor-permeable air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

2.3 VAPOR-PERMEABLE MEMBRANE AIR-BARRIER

A. Fluid-Applied, Vapor-Permeable Membrane Air Barrier: synthetic polymer membrane.

1. **Synthetic Polymer Membrane:**
   a. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
      1) Carlisle Coatings & Waterproofing Inc.
      3) Grace Construction Products; W.R. Grace & Co. -- Conn.
      4) Henry Company, Sealants Division.
      5) PROSOCO, Inc.
      6) Rubber Polymer Corporation, Inc.
      7) Sto Corp.
      8) Tremco Incorporated.

2. **Physical and Performance Properties:**
   a. **Air Permeance:** Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. (0.02 L/s x sq. m of surface area at 75-Pa) pressure difference; ASTM E 2178.
   b. **Vapor Permeance:** Minimum 10 perms (580 ng/Pa x s x sq. m) ASTM E 96/E 96M.
   c. **Ultimate Elongation:** Minimum 200 percent; ASTM D 412, Die C.
   d. **Fire Propagation Characteristics:** Passes NFPA 285 testing as part of an approved assembly.
2.4 ACCESSORY MATERIALS

A. General: Accessory materials recommended by air-barrier manufacturer to produce a complete air-barrier assembly and compatible with primary air-barrier material.

B. Sprayed Polyurethane Foam Sealant: One- or two-component, foamed-in-place, polyurethane foam sealant, 1.5- to 2.0-lb/cu. ft (24- to 32-kg/cu. m) density; flame-spread index of 25 or less according to ASTM E 162; with primer and noncorrosive substrate cleaner recommended by foam sealant manufacturer.

C. Termination Mastic: Air-barrier manufacturer's standard cold fluid-applied elastomeric liquid; trowel grade.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.

B. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.

C. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

D. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

3.2 INSTALLATION

A. General: Install fluid-applied membrane air-barrier and accessory materials according to air-barrier manufacturer's written instructions to form a seal with adjacent construction and maintain a continuous air barrier.

1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.

2. Install air-barrier assembly on roofing membrane or base flashing so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate.

B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by fluid air-barrier material on same day. Reprime areas exposed for more than 24 hours.

1. Prime glass-fiber-suraced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.
C. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louveres, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

D. At end of each working day, seal top edge of air barrier to substrate with termination mastic.

E. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transitions and flashing so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate. Maintain 3 inches (75 mm) of full contact over firm bearing to perimeter frames with not less than 1 inch (25 mm) of full contact.

F. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air-barrier material with foam sealant.

G. Seal air-barrier assembly around masonry reinforcing or ties and penetrations with termination mastic.

H. Seal top of through-wall flashings to air barrier.

I. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.

J. Repair punctures, voids, and deficient lapped seams. Slit and flatten fishmouths and blisters. Extend patches 6 inches (150 mm) beyond repaired areas.

K. Fluid-Applied Membrane Material: Apply a continuous unbroken air-barrier membrane to substrates according to the following thickness. Apply air-barrier membrane in full contact around protrusions such as masonry ties.

1. Vapor-Permeable Membrane Air Barrier: Total dry film thickness as recommended in writing by manufacturer to meet performance requirements, but not less than 40-mil (1.0-mm) dry film thickness

L. Do not cover air barrier until it has been tested and inspected by Owner's testing agency.

M. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements.

C. Air barriers will be considered defective if they do not pass tests and inspections.
1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
2. Remove and replace deficient air-barrier components for retesting as specified above.

D. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

E. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.

1. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer. If exposed to these conditions for more than 30 days, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed membrane according to air-barrier manufacturer's written instructions.
2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.

F. Remove masking materials after installation.

END OF SECTION 072726
SECTION 074213 METAL WALL PANELS

PART 1 - GENERAL

1.1 Scope of Work
   A. Work of this Section shall include design, fabrication, supply and installation of aluminium composite panels and aluminium plate panels.

1.2 Related Work
   A. Division 7 Section “Vapor, Moisture, and Air Barriers” for applicable weather barriers associated with rain screen panel systems.

1.3 Quality Assurance
   A. Manufacturer Qualifications: All primary panel products specified in this section will be supplied by a single manufacturer with a minimum of ten years experience.
      i. Products covered under the work listed in this section are to be manufactured in an ISO 9001 certified facility.
   B. Supplier/installer shall have minimum 10 years proven experience and must have completed at least 5 major projects in the specified aluminium composite material panel system.
   C. Manufacturer Field Services: Upon Owner’s request, provide manufacturer’s field service consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer’s instructions.
   D. Panel system manufacturer shall be registered as a “Premium MCM Fabricator” with the Metal Construction Association (www.metalconstruction.org).

1.4 Design and Performance Requirements
   A. Design, fabricate and erect a pressure equalized wall panel system to meet the following requirements.
      1. Rain Penetration: prevent rain penetration through wall system. Design system based on “Rain Screen Principle”. Incorporate means of draining to the exterior.
      2. Wind Load: Design wall system to resist wind loads, positive and negative, expected in this geographical region without causing rattling, vibration or excessive deflection of panels, overstressing of fasteners, clips and other detrimental effects on system.
      3. Structural and Thermal Movement: Accommodate movement of supporting structural framing and movement caused by thermal expansion and contraction of system component parts without causing bowing, buckling, delamination, oil canning, failure of joint seals, excessive stress on fasteners or any other detrimental effects.
   B. Panel flatness tolerance: Fabricate panels not exceeding the following tolerances:
      1. Rises and falls across panel, (local bumps and depressions) will not be accepted.
      2. .080” (2mm) in a concave/convex direction, measured perpendicular to normal plane.
C. Maximum deviation from vertical and horizontal alignment of erected panels: 1/4" in 20'-0”.

D. Testing: Provide a complete panel system that has been tested and certified to conform with AAMA 508-07, per the following criteria:
   1. Air Leakage: Not more than 0.006 (cfm)/sf of wall area (.003(L/s)m², when tested at 6.24 psf (300 Pa) in accordance with ASTM E283.
   2. Water Penetration: No water infiltration under static pressure when tested in accordance with ASTM E331 at a pressure level of 14.61 psf (700 kPa) minimum, after 15 minutes.
      a. Water penetration is defined as the appearance of uncontrolled water in the wall.
      b. Wall design shall feature provisions to drain to the exterior face of the wall any leakage of water at joints and any condensation that may occur within the construction.
   3. Structural: Provide systems that have been tested in accordance with ASTM E330 at a design pressure of 65 psf (3.12 kPa) and have been certified to be without permanent deformation of failures of structural members.
   4. Pressure Equalization: Provide systems that perform in accordance with ASTM E1233-Modified – 100 three-second cycles at 1,200 Pa (25 psf).

1.5 Samples
   A. Submit samples in accordance with general requirements.
   B. Submit duplicate, minimum 5” x 7” samples of each color selected.

1.6 Shop Drawings
   A. Submit shop drawings in accordance with general requirements.
   B. Indicate elevations, profiles, dimensions and thickness of panels and joint details.
   C. Indicate attachment clips, system extrusions, fastening, anchor and installation details.

1.7 Engineering Calculations
   A. Submit engineering calculations as required by the local building code, showing that the installed panel system meets the wind load requirements for the project.

1.8 Maintenance Data
   B. Provide maintenance data for cleaning and maintenance of aluminum finishes for incorporation into manual.

1.8 Product Delivery, Handling and Storage
   A. Protect panel face with a plastic film adhered to panel in accordance with panel manufacturer’s recommendation.
   C. Store components and materials in accordance with panel manufacturer’s recommendations.
1.9 Kynar Panel Finish Warranty
   A. Provide a manufacturer’s written warranty: Furnish panel manufacturer’s written warranty covering failure of factory-applied exterior finish on composite metal panels within the warranty period; warrant finish per ASTM D 4214 for chalk not in excess of 8 NBS units and fade not in excess of 5 NBS units. Warranty period for finish; 20 years after the date of substantial completion.

1.10 Material and Workmanship Warranty
   A. Warranty against defects or deficiencies in panel system materials and workmanship shall be for a period of one (1) year from date of substantial completion.

PART 2 - PRODUCTS

2.1 Panels
   A. Metal Composite Material (MCM)
      1. Composition: Two sheets of aluminum sandwiching a core of extruded thermoplastic, formed in a continuous process without the use of glues or adhesives between dissimilar materials. Bond integrity testing to adhere to ASTM D1781-76
         a. Aluminum face sheets: aluminum alloy 3003, thickness: 0.020” (0.51mm)
         b. Panel thickness: 4 mm (.157”)
         c. Panel weight: 1.12 lbs/sq.ft (5.5 kg/sq.m.)
      2. Tolerances:
         a. Panel bow: Maximum 0.8% of panel dimension (width or length).
         b. Panel Dimensions: Take site measurements before proceeding with production unless dimensions can be guaranteed by General Contractor.
         c. Panel lines, breaks and angles to be sharp and true; panel surfaces to be free from warp or buckle.
      3. Acceptable panel material manufacturers:
         a. Alucobond, as manufactured by 3A Composites, Inc.
         b. Alpolic, as manufactured by Mitsubishi
         c. Reynobond, as manufactured by Alcoa

   B. Plate Material
      1. Single aluminium plate material
         a. Panel Thickness: 3.175 mm (.125”)
         b. Panel Dimensions: Take site measurements before proceeding with production unless dimensions can be guaranteed by General Contractor.
         c. Panel lines, breaks and angles to be sharp and true; panel surfaces to be free from warp or buckle.
         d. Plate panel returns must be back routed using “VEE” cut, to provide sharp, true edges.
D. Panel System: Basis of design is SL-2000 dry-joint, rain screen, as engineered and fabricated by Sobotec, Ltd. (represented by Spohn Associates, Inc 937/299-0781), featuring ½" (12.5mm) wide panel joints, and using full-perimeter aluminium extrusions. Equal systems by Elward or Keith Panel Systems are acceptable.
   1. Alternate panel system fabricators must submit full mock-up, product and test data at least ten (10) days prior to bid date, and must meet the following qualifications. System must be provided by a Premium MCM Fabricator, as listed by the Metal Construction Association.

E. Panel finishes: Two-coat or three-coat fluoropolymer (Kynar or equal), coil-coated (spray-applied for plate material) baked enamel finish containing Kynar 500 (or equal) polyvinylidene fluoride resin. Four (4) custom colors, to match samples provided by architect.

F. Panel and Wall Accessories:
   1. Fasteners: As recommended by the panel manufacturer, concealed and non-corrosive.
   2. Extrusions and extrusion clips for attaching panels to the sub-structure: purpose made aluminum. Extrusions shall be full length around panel perimeter for panel reinforcement and alignment. Intermittent clips are unacceptable.
   3. Sub-girts: If required, to be manufactured from G-90 galvanized and shall be designed to accommodate expansion and contraction, dynamic movements and design load requirements.
   4. Joint filler strip: same material and color as panels. Use of caulking at joints is not acceptable.

G. Deep Cavity Spacer System: As part of the complete panel system, engineer, furnish and install thermal spacing clips in size, frequency, and locations as determined by the system fabricator, to accommodate exterior insulation and to support the full loads imposed by the panel system, and so as to prevent/minimize thermal transfer. Use 18ga. galvanized sub-girt framing in accordance with manufacturer’s recommendations to accommodate panel system attachment. Fasten sub-girt to face of clips, so that insulation is uninterrupted (zeep girt configurations in lieu of clips are unacceptable).

H. Exterior Insulation: As part of the complete panel system, furnish and install rigid extruded polystyrene insulation within the exterior wall cavity. Secure insulation per manufacturer’s installation instructions. Thickness of insulation to be determined by the panel system fabricator. Minimum R-10

PART 3 – INSTALLATION EXECUTION

3.1 Wall Panel System

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A. Before proceeding, examine work of other sections upon which this section depends. Any imperfections or inconsistencies in the substrate shall be reported to the general contractor and suitably corrected prior to panel installation.

B. Panels are to be delivered to site ready for immediate installation to structural steel support and sheathing. Field fabrication is unacceptable.

3.2 Panel System Installation

A. Erect panels and joint filler strip in accordance with system manufacturer’s details and instructions and so as to meet specified design and performance criteria.

B. Finished work shall be securely anchored, free of distortion and surface imperfections, uniform in colour.

C. Use concealed fastenings only.

D. Install sections plumb, true, level and in alignment to established lines and elevations.

3.3 Clean-up

A. Remove protective film from panels.

B. Repair and touch-up with color matching high grade enamel minor surface damage.

C. Replace damaged panels and components which cannot be satisfactorily repaired.

END
SECTION 075423 - THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes:
   1. Membrane Roofing System
   2. Roof Insulation
   3. Roof Walkways
B. Related Sections
   1. Section 018113 – Sustainability Requirements

1.3 EXTENT OF WORK
A. Provide all labor, material, tools, equipment, and supervision necessary to complete the installation of a .060”, thick white or tan reinforced TPO (Thermoplastic Polyolefin) reinforced membrane Adhered Roofing System including flashings and insulation as specified herein and as indicated on the drawings in accordance with the manufacturer’s most current specifications and details.
B. The roofing contractor shall be fully knowledgeable of all requirements of the contract documents and shall make themselves aware of all job site conditions that will affect their work.
C. The roofing contractor shall confirm all given information and advise the building owner, prior to bid, of any conflicts that will affect their cost proposal.

1.4 SUBMITTALS
A. Prior to starting work, the roofing contractor must submit the following:
   1. Shop drawings showing layout, details of construction seam layout and identification of materials.
   2. A sample of the manufacturer’s Membrane System Warranty.
   3. Submit a letter of certification from the manufacturer which certifies the roofing contractor is authorized to install the manufacturer’s roofing system.
   4. Certification from the membrane manufacturer indicating the membrane thickness over the reinforcing scrim (tip ply membrane thickness) is nominal .015” (15 mil).
   5. Certification of the manufacturer’s warranty reserve.
6. Product Data: for each type of product indicated.
7. LEED Submittals.
   a. Energy Performance: Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.
8. Samples: for each type of product indicated.
9. Upon completion of the installed work, submit copies of the manufacturer’s final inspection to the specifier prior to the issuance of the manufacturer’s warranty.

1.5 QUALITY ASSURANCE

A. Preinstallation Roofing Conference: Conduct conference at Project site.
   1. Meet with Owner, Architect, roofing installer, roofing system manufacturer’s representative, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
   2. Review methods and procedures related to roofing installation, including manufacturer’s written instructions.
   3. Review and finalize construction schedule and verify availability of materials, Installer’s personnel, equipment, and facilities needed to make progress and avoid delays.
   4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
   5. Review structural loading limitations of roof deck during and after roofing.
   6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
   7. Review temporary protection requirements for roofing system during and after installation.
   8. Review roof observation and repair procedures after roofing installation.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the job site in the manufacturer’s original, unopened containers or wrappings with the manufacturer’s name, brand name and installation instructions intact and legible. Deliver in sufficient quantity to permit work to continue without interruption.

B. Comply with the manufacturer’s written instructions for proper material storage.

C. 1. TPO membrane in the original undisturbed plastic wrap in a cool, shaded area. TPO membrane that has been exposed to the elements for approximately 7 days must be prepared with TPO manufacturer’s cleaner prior to hot air welding.
   2. Store curable materials (adhesives and sealants) between 60°F and 80°F in dry areas protected from water and direct sunlight. If exposed to lower temperature, restore to 60°F minimum temperature before using.
   3. Store materials containing solvents in dry, well ventilated spaces with proper fire and safety precautions. Keep lids on tight. Use before expiration of their shelf life.

D. Insulation must be on pallets, off the ground and tightly covered with waterproof materials.
E. Any materials which are found to be damaged shall be removed and replaced at the applicator’s expense.

1.7 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

B. Job Site Protection:

1. The roofing contractor shall adequately protect building, paved areas, service drives, lawn, shrubs, trees, etc. from damage while performing the required work. Provide canvas, boards and sheet metal (properly secured) as necessary for protection and remove protection material at completion. The contractor shall repair or be responsible for costs to repair all property damaged during the roofing application.

2. Do not overload any portion of the building, by either use of or placement of equipment, storage of debris, or storage of materials.

3. Protect against fire and flame spread. Maintain proper and adequate fire extinguishers.

4. Take precautions to prevent drains from clogging during the roofing application. Remove debris at the completion of each day's work and clean drains, if required. At completion, test drains to ensure the system is free running and drains are watertight. Remove strainers and plug drains in areas where work is in progress. Install flags or other telltales on plugs. Remove plugs each night and screen drain.

5. Store moisture susceptible materials above ground and protect with waterproof coverings.

6. Remove all traces of piled bulk material and return the job site to its original condition upon completion of the work.

1.8 SAFETY

A. The roofing shall be responsible for all means and methods as they relate to safety and shall comply with all applicable local, state and federal requirements that are safety related. Safety shall be the responsibility of the roofing contractor. All related personnel shall be instructed daily to be mindful of the full time requirement to maintain a safe environment for the facility's occupants including staff, visitors, customers and the occurrence of the general public on or near the site.

1.9 WORKMANSHIP

A. Applicators installing new roof, flashing and related work shall be factory trained and approved by the manufacturer they are representing.

B. All work shall be of highest quality and in strict accordance with the manufacturer's published specifications and to the building owner's satisfaction.

C. There shall be a supervisor on the job site at all times while work is in progress.
1.10 WARRANTY

A. Provide manufacturer's Total System Warranty covering both labor and material with no dollar limitation. The maximum wind speed coverage shall be peak gusts of (72 mph) measured at 10 meters above ground level. Certification is required with bid submittal indicating the manufacturer has reviewed and agreed to such wind coverage. Warranty Period: Twenty (20) years from date of Substantial Completion. TOTAL SYSTEM WARRANTY SHALL COVER ALL ROOFING COMPONENTS INCLUDING EDGE METALS, FLASHINGS, COPINGS, ETC.

B. Provide a written guarantee warranting the roofing, insulation, and flashing work, including the installation of products furnished by others and installed under this Section of the Work, against defects in materials and workmanship for a period of 2 years.

C. Pro-rated System Warranties shall not be accepted.

PART 2 - PRODUCTS

2.1 GENERAL

A. All products (including insulation, fasteners, fastening plates and edgings) must be manufactured and/or supplied by the roofing system manufacturer and covered by the warranty.

2.2 MEMBRANE

A. Furnish (060") thick (white or tan) reinforced TPO (Thermoplastic Polyolefin) membrane as needed to complete the roofing system. Membrane thickness over the reinforcing scrim (top-ply thickness) shall be nominal .015” thick (15 mil)

2.3 ROOF INSULATION

A. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.

B. The entire roof insulation system shall consist of a minimum of two layers of insulation with all joints staggered a minimum of 6”. The bottom layer shall be 2” thick. The upper layer(s) shall be a minimum of 1½” thick.

C. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated and where required to provide positive slope to the gutters. Provide crickets at the up-slope side of all straight roof penetrations where the dimension perpendicular to the roof slope is 12” or greater. Fabricate to slopes indicated.

D. Provide the insulation manufacturers engineered tapered roof insulation system at roof areas that include roof drains, and at roof areas where the roof framing system does not provide the roof slope indicated on the Roof Plan.
E. Total insulation system shall achieve a minimum average “R” factor of 28. Minimum thickness shall be 4”.

2.4 INSULATION ACCESSORIES

A. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer. Fasteners shall be capable of being painted at interior where penetrating decking. There are areas of exposed deck for ceilings and these shall be painted. Use fasteners in these areas that will minimally penetrate the deck while still providing required fastening strength.

B. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with membrane roofing.

C. Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/4 inch (6 mm) thick, factory primed.
   1. Products: Subject to compliance with requirements, provide one of the following
      a. CertainTeed Corporation; GlasRoc Sheathing Type X.
      b. Georgia-Pacific Corporation; Dens Deck DuraGuard.
      c. National Gypsum Company; Gold Bond eXP Extended Exposure Sheathing.
      d. Temple-Inland, Inc; GreenGlass Exterior Sheathing.
      e. USG Corporation; Securock Glass Mat Roof Board.

2.5 ADHESIVES AND CLEANERS

A. All products shall be furnished by The Membrane Manufacturer and specifically formulated for the intended purpose.
   2. Edge Sealant: Cut Edge Sealant.
   5. Cleaner: Manufacturer’s Weathered Membrane Cleaner.

2.6 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads, approximately 3/16 inch (5 mm) thick, and acceptable to membrane roofing system manufacturer.

2.7 MANUFACTURERS

A. Approved Manufacturers:
   1. Carlise, Sure-Weld TPO
   2. Versico, VersiWeld TPO
   3. GAF, EverGuard TPO
   4. Firestone Ultraply TPO
PART 3 - EXECUTION

3.1 GENERAL

A. Comply with the manufacturer's published instructions for the installation of the membrane roofing system including proper substrate preparation, job site considerations and weather restrictions.

B. Position sheets to accommodate contours of the roof deck and shingle splices to avoid bucking water.

3.2 INSULATION PLACEMENT AND ATTACHMENT

A. Install insulation or membrane underlayment over the substrate with boards butted tightly together with no joints or gaps greater than 1/4 inch. Stagger joints in multiple layers of insulation horizontally and vertically.

B. Secure insulation to the substrate with the required manufacturer’s fasteners and 3 inch diameter Insulation Fastening Plates in accordance with manufacturer’s specification.

3.3 MEMBRANE PLACEMENT AND ATTACHMENT

A. Position TPO membrane over the acceptable substrate. Fold membrane sheet back lengthwise (onto itself) so half the underside of the membrane is exposed.

B. Apply Bonding Adhesive in accordance with the manufacturer's published instructions, to the exposed underside of the membrane and the corresponding substrate area. Do not apply Bonding Adhesive along the splice edge of the membrane to be hot air welded over the adjoining sheet. Allow the adhesive to dry until it is tacky but will not string or stick to a dry finger touch.
   1. Roll the coated membrane into the coated substrate while avoiding wrinkles. Brush down the bonded section of the membrane sheet immediately after rolling the membrane into the adhesive with a soft bristle push broom to achieve maximum contact.
   2. Fold back the unbonded half of the sheet lengthwise and repeat the bonding procedures.

C. Position adjoining sheets to allow a minimum overlap of 2 inches.

D. Hot air weld the TPO membrane sheets using the Automatic Hot Air Welding Machine or Hot Air Hand Welder in accordance with the manufacturer's hot air welding procedures.

E. Pull the membrane back along the welded splice so the entire underside of the membrane is exposed once the Hot Air Weld has been completed.

F. Apply Manufacturer’s Two-Sided Bonding Adhesive to the exposed underside of the membrane sheet and the substrate.
G. Allow adhesive to dry until tacky and roll the membrane into the substrate and brush down the bonded section with a bristle broom following the procedure noted above.

H. Continue to install adjoining membrane sheets in the same manner, overlapping edges a minimum of 2 inches and complete the bonding procedures as stated previously.

3.4 MEMBRANE SPLICING/HOT AIR WELDING PROCEDURES

A. Hot air weld the TPO membrane using an Automatic Hot Air Welding Machine or Hot Air Hand Welder in accordance with the manufacturer's specifications. At all splice intersections, roll the seam with a silicone roller to ensure a continuous hot air welded seam. (All .060” splice intersections shall be overlaid with manufacturer’s non-reinforced flashing).

B. Probe all seams once the hot air welds have thoroughly cooled (approximately 30 minutes).

C. Repair all seam deficiencies the same day they are discovered.

D. Apply Cut Edge Sealant on all cut edges of reinforced membrane (where the scrim reinforcement is exposed) after seam probing is complete. Cut Edge Sealant is not required on vertical splices.

3.5 FLASHING

A. Flashing of parapets, curbs, expansion joints and other parts of the roof must be performed using manufacturer’s TPO reinforced membrane. Manufacturer’s non-reinforced membrane can be used for flashing pipe penetrations, Sealant Pockets, and scuppers, as well as inside and outside corners, when the use of pre-molded accessories is not feasible.

B. Follow manufacturer's typical flashing procedures for all wall, curb, and penetration flashing including metal edging/coping and roof drain applications.

3.6 ROOF DRAINS

A. The roof drains, secondary roof drains and metal sump pans are provided and installed as part of the Division 22 work.

B. Provide and install all flashing, mastic and related materials required for the attachment of the Membrane Roofing System to the roof drain assembly. Installation shall be in accordance with the membrane manufacturer’s details and requirements.

3.7 WALKWAY INSTALLATION

A. Flexible Walkways: Install walkway products in locations indicated. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions. Leave 3 inches (75 mm) of space between adjacent walkway sections.
3.8 DAILY SEAL

A. On phased roofing, when the completion of flashings and terminations is not achieved by the end of the work day, a daily seal must be performed to temporarily close the membrane to prevent water infiltration.

B. Complete an acceptable membrane seal in accordance with the manufacturer’s requirements.

3.9 CLEAN UP

A. Perform daily clean up to collect all wrappings, empty containers, paper, and other debris from the project site. Upon completion, all debris must be disposed of in a legally acceptable manner.

B. Prior to the manufacturer’s inspection for warranty, the applicator must perform a pre-inspection to review all work and to verify all flashing has been completed as well as the application of all caulking

3.10 FIELD QUALITY CONTROL

A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.

B. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements. A copy of this inspection report shall be submitted to the Architect upon completion of the inspection.

END OF SECTION 07 53 23
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Copings.
   2. Roof-edge flashings.
   3. Roof-edge drainage systems.
   4. Reglets and counterflashings.
   5. Wall Sheet Metal Fabrications

B. Related Sections
   1. Section 018113 – Sustainability Requirements

1.2 PERFORMANCE REQUIREMENTS

A. SPRI Wind Design Standard: Manufacture and install copings and roof-edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressures:
   1. Design Pressure: As indicated on Drawings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For roof specialties. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work.

C. Samples: For each exposed product and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.
1.6 QUALITY ASSURANCE

A. Pre-installation Conference: Conduct conference at Project site.

1.7 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within 20 years from date of Substantial Completion.

B. Total system warranty – refer to roofing specification for additional requirements on the total system warranty for roofing system.

PART 2 - PRODUCTS

2.1 EXPOSED METALS

A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation.

1. Surface: Smooth, flat finish.
2. Exposed Coil-Coated Finishes: Prepainted by the coil-coating process to comply with ASTM A 755/A 755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Two-Coat Fluoropolymer: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.

2.2 CONCEALED METALS

A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation.

2.3 UNDERLAYMENT MATERIALS

A. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

B. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29 deg C).
C. Polyethylene Sheet: 6-mil- (0.15-mm-) thick polyethylene sheet complying with ASTM D 4397.

D. Slip Sheet: Building paper, 3-lb/100 sq. ft. (0.16-kg/sq. m) minimum, rosin sized.

2.4 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:

1. Fasteners for Copper Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.
2. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A 153/A 153M or ASTM F 2329.

C. Elastomeric Sealant: ASTM C 920, elastomeric polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.

D. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

E. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

F. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

G. Solder for Copper: ASTM B 32, lead-free solder.

2.5 COPINGS

A. Copings: Manufactured coping system consisting of formed-metal coping cap in section lengths not exceeding 12 feet (3.6 m) concealed anchorage; corner units, end cap units, and concealed splice plates with same finish as coping caps.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Architectural Products Company
   b. ATAS International, Inc
   c. Castle Metal Products
   d. Cheney Flashing Company
   e. Hickman Company, W. P.
   f. Johns Manville
   g. Merchant & Evans, Inc.
2. Coping-Cap Material: Zinc-coated steel, nominal thickness as required to meet performance requirements.
   a. Finish: Three-coat fluoropolymer
   b. Color: Custom color to match Architects paint color selection


4. Coping-Cap Attachment Method: Snap-on fabricated from coping-cap material.

5. Snap-on-Coping Anchor Plates: Concealed, galvanized-steel sheet, 12 inches (300 mm) wide, with integral cleats.

6. Face Leg Cleats: Concealed, continuous galvanized-steel sheet.

2.6 ROOF-EDGE FLASHINGS

A. Canted Roof-Edge Fascia and Gravel Stop: Manufactured, two-piece, roof-edge fascia consisting of snap-on metal fascia cover in section lengths not exceeding 12 feet (3.6 m) and a continuous formed galvanized-steel sheet cant, 0.028 inch (0.71 mm) thick, minimum, with extended vertical leg terminating in a drip-edge cleat. Provide matching corner units.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Architectural Products Company
   b. ATAS International, Inc.
   c. Castle Metal Products
   d. Cheney Flashing Company
   e. Hickman Company, W. P.
   f. Johns Manville
   g. Merchant & Evans, Inc.
   h. Metal-Era, Inc.
   i. Metal-Fab Manufacturing, LLC.
   j. MM Systems Corporation
   k. National Sheet Metal Systems, Inc.
   l. Petersen Aluminum Corporation

2. Fascia Cover: Fabricated from the following exposed metal:
   a. Zinc-Coated Steel: Nominal thickness as required to meet performance requirements.
   b. Finish: Three-Coat fluoropolymer
   c. Color: Custom color to match Architects paint color selection


4. Splice Plates: Concealed of same material, finish, and shape as fascia cover.
5. Fascia Accessories: Fascia extenders with continuous hold-down cleats, Overflow scuppers.

B. One-Piece Gravel Stops: Manufactured, one-piece, metal gravel stop in section lengths not exceeding 12 feet (3.6 m), with a horizontal flange and vertical leg fascia terminating in a drip edge, and concealed splice plates of same material, finish, and shape as gravel stop. Provide matching corner units.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Architectural Products Company.
   b. Berger Building Products, Inc.
   c. Castle Metal Products.
   d. Cheney Flashing Company.
   e. Hickman Company, W. P.
   f. Metal-Era, Inc.
   g. Metal-Fab Manufacturing, LLC.
   h. MM Systems Corporation.
   i. National Sheet Metal Systems, Inc.
   j. Perimeter Systems; a division of Southern Aluminum Finishing Company, Inc.
   k. Petersen Aluminum Corporation.

2. Fabricate from the following exposed metal:
   a. Zinc-Coated Steel: Nominal thickness as required to meet performance requirements.

3. Corners: Factory mitered and continuously welded
5. Finish: Three-coat fluoropolymer
6. Color: Custom color to match Architects paint color selection

C. Special shapes and sizes
1. Refer to drawings for special shapes and sizes – in particular over the new addition high roof area.

2.7 ROOF-EDGE DRAINAGE SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Andreas Renner KG.
3. ATAS International, Inc.
5. Castle Metal Products.
7. CopperCraft by FABRAL; a Euramax company.
8. Hickman Company, W. P.
10. Merchant & Evans, Inc.
11. Metal-Era, Inc.
12. Metal-Fab Manufacturing, LLC.

B. Parapet Scuppers: Manufactured with closure flange trim to exterior, 4-inch- (100-mm-) wide wall flanges to interior, and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof.

1. Fabricate from the following exposed metal:
   a. Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness.

2.8 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters: Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch- (2400-mm-) long sections. Furnish flat-stock gutter brackets and gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard but with thickness not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers, and gutter accessories from same metal as gutters. Shop fabricate interior and exterior corners.

1. Accessories: Continuous, removable leaf screen with sheet metal frame and hardware cloth screen.

B. Downspouts: Fabricate rectangular downspouts to dimensions indicated, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors.

1. Hanger Style: strap
2. Fabricate from the following materials:
   a. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
   b. Zinc-Coated Steel Finish: Three-coat fluoropolymer.
   c. Color: Custom color to match Architects paint color selection

C. Downspout boots
1. Provide prefabricated aluminum downspout boot for transition from downspout to storm piping.
2. Height – 1’
3. Rectangular downspout to round outlet at storm
4. Coordinate required sizes with drawings
5. Natural sand cast finish

2.9 REGLETS AND COUNTERFLASHINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Castle Metal Products.
2. Cheney Flashing Company.
3. Fry Reglet Corporation.
4. Heckmann Building Products Inc.
5. Hickman Company, W. P.
7. Metal-Era, Inc.
8. Metal-Fab Manufacturing, LLC.

B. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:
1. Zinc-Coated Steel: Nominal 0.022-inch (0.56-mm) thickness.
2. Corners: Factory mitered and continuously welded.
3. Masonry Type, Embedded: Provide reglets with offset top flange for embedment in masonry mortar joint.

C. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches (100 mm) and in lengths not exceeding 12 feet (3.6 m) designed to snap into reglets or through-wall-flashing receiver and compress against base flashings with joints lapped, from the following exposed metal:
1. Zinc-Coated Steel: Nominal 0.022-inch (0.56-mm) thickness.
   a. Color: Custom color to match Architects paint color selection

D. Accessories:
1. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.
2. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

E. Zinc-Coated Steel Finish: Three-coat fluoropolymer.
   a. Color: Custom color to match Architects paint color selection

2.10 WALL SHEET METAL FABRICATIONS

A. Metal Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch- (2400-mm-) long, but not exceeding 12-foot- (3.6-m-) long, sections, under copings, at shelf angles, and where indicated. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches (150 mm) beyond each side of wall openings. Form with 2-inch- (50-mm-) high, end dams where flashing is discontinuous. Fabricate from the following materials:
1. Aluminum: 03050 inch thick.
3.1 INSTALLATION, GENERAL

A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete roof-specialty systems.

1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
2. Provide uniform, neat seams with minimum exposure of solder and sealant.
3. Install roof specialties to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
4. Torch cutting of roof specialties is not permitted.
5. Install underlayment with adhesive for temporary anchorage. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet.


1. Space movement joints at a maximum of 12 feet (3.6 m) with no joints within 18 inches (450 mm) of corners or intersections unless otherwise shown on Drawings.
2. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.

D. Fastener Sizes: Use fasteners of sizes that will penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Seal joints with sealant as required by roofing-specialty manufacturer.

F. Seal joints as required for watertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F (4 deg C).

3.2 COPING INSTALLATION

A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.
B. Anchor copings to meet performance requirements.
   1. Interlock face and back leg drip edges of snap-on coping cap into cleated anchor plates anchored to substrate at manufacturer's required spacing that meets performance requirements.

3.3 ROOF-EDGE FLASHING INSTALLATION
A. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.
B. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

3.4 ROOF-EDGE DRAINAGE-SYSTEM INSTALLATION
A. General: Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions.
B. Parapet Scuppers: Install scuppers where indicated through parapet. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.

3.5 REGLET AND COUNTERFLASHING INSTALLATION
A. Embedded Reglets: Saw cut existing mortar joint for insulation of reglets.
B. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap 4 inches (100 mm) over top edge of base flashings. Lap counterflashings joints a minimum of 4 inches (100 mm) and bed with sealant. Fit counterflashings tightly to base flashings.

3.6 CLEANING AND PROTECTION
A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
B. Clean and neutralize flux materials. Clean off excess solder and sealants.
C. Remove temporary protective coverings and strippable films as roof specialties are installed.

END OF SECTION 077100
SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Roof hatches.

B. Related Sections
   1. Section 018113 – Sustainability Requirements

1.2 ACTION SUBMITTALS

A. Product Data: For each type of roof accessory indicated.

B. Shop Drawings: For roof accessories.

C. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items.

B. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within 20 years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 METAL MATERIALS

A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation.
   1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
   2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil (0.005 mm).
   3. Exposed Coil-Coated Finish: Two-coat fluoropolymer finish; AAMA 621; system consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
   4. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat.

B. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, AZ50 (AZM150) coated.
   1. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil (0.005 mm).
   2. Exposed Coil-Coated Finish: Two-coat fluoropolymer finish; AAMA 621; system consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
   3. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat.

C. Aluminum Sheet: ASTM B 209 (ASTM B 209M), manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.
   1. Mill Finish: As manufactured.
   2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil (0.005 mm).
   3. Clear Anodic Finish: AAMA 611, Class II, 0.010 mm or thicker.
   4. Color Anodic Finish: AAMA 611, Class II, 0.010 mm or thicker.
   5. Exposed Coil-Coated Finish: Two-coat fluoropolymer finish; AAMA 620; system consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
   6. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm).

D. Aluminum Extrusions and Tubes: ASTM B 221 (ASTM B 221M), manufacturer's standard alloy and temper for type of use, finished to match assembly where used, otherwise mill finished.
E. Stainless-Steel Sheet and Shapes: ASTM A 240/A 240M or ASTM A 666, Type 304.

F. Steel Shapes: ASTM A 36/A 36M, hot-dip galvanized according to ASTM A 123/A 123M unless otherwise indicated.

2.2 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches (38 mm) thick.

C. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners.

D. Sealants: As recommended by roof accessory manufacturer for installation indicated.

2.3 ROOF HATCH

A. Roof Hatches: Metal roof-hatch units with lids and insulated double-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AES Industries, Inc.
   b. Babcock-Davis.
   c. Bilco Company (The).
   d. Bristolite Skylights.
   e. Custom Solution Roof and Metal Products.
   f. Dur-Red Products.
   g. Hi Pro International, Inc.
   h. J. L. Industries, Inc.
   i. Metallic Products Corp.
   j. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
   k. Naturalite Skylight Systems; Vistawall Group (The).
   l. Nystrom.
   m. O'Keeffe's Inc.
   n. Pate Company (The).
   o. Precision Ladders, LLC.

B. Type and Size: Single-leaf lid, 30 by 30 inches (750 by 750 mm).
C. **Loads:** Minimum 40-lbf/sq. ft. (1.9-kPa) external live load and 20-lbf/sq. ft. (0.95-kPa) internal uplift load.

D. **Hatch Material:** Aluminum sheet, 0.090 inch (2.28 mm) thick.
   1. **Finish:** Baked enamel or powder coat.
   2. **Color:** As selected by Architect from manufacturer's full range.

E. **Construction:**
   1. **Insulation:** Polyisocyanurate board.
   2. **Hatch Lid:** Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
   3. **Curb Liner:** Manufacturer's standard, of same material and finish as metal curb.
   4. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
   5. Fabricate curbs to minimum height of 12 inches (300 mm) unless otherwise indicated.
   6. **Sloping Roofs:** Where slope or roof deck exceeds 1:48, fabricate curb with perimeter curb height that is tapered to accommodate roof slope so that top surfaces of perimeter curb are level. Equip hatch with water diverter or cricket on side that obstructs water flow.

F. **Hardware:** Galvanized-steel spring latch with turn handles, butt- or pintle-type hinge system, and padlock hasps inside.

G. **Safety Railing System:** Roof-hatch manufacturer's standard system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.

H. **Ladder-Assist Post:** Roof-hatch manufacturer's standard device for attachment to roof-access ladder. Post locks in place on full extension; release mechanism returns post to closed position.

**PART 3 - EXECUTION**

3.1 **INSTALLATION**

A. **General:** Verify dimensions of roof openings for roof accessories. Install roof accessories according to manufacturer's written instructions.
   1. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
   2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
   3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
   4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.

2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet, or install a course of polyethylene sheet.

C. Seal joints with sealant as required by roof accessory manufacturer.

3.2 REPAIR AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780.

B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

C. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200
SECTION 07 84 13 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Penetrations in fire-resistance-rated walls.
   2. Penetrations in horizontal assemblies.
   3. Penetrations in smoke barriers.

B. Related Sections:
   1. Section 018113 – Sustainability Requirements

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

   1. Product Data for Credit IEQ 4.1: For penetration firestopping sealants and sealant primers, documentation including printed statement of VOC content.

   2. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

   3. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regionally manufactured and regionally extracted and manufactured materials. Include statement indicating cost for each regionally manufactured material.
      a. Include statement indicating location of manufacturer and distance to Project for each regionally manufactured material.
      b. Include statement indicating location of manufacturer and point of extraction, harvest, or recovery for each raw material used in regionally extracted and manufactured materials. Indicate distance to Project and fraction by weight of each regionally manufactured material that is regionally extracted.

C. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.

   1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping
manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.3 INFORMATIONAL SUBMITTALS

A. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.

B. Product test reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

B. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:

1. Penetration firestopping tests are performed by UL or FM Global.
2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems bearing marking of qualified testing and inspection agency.

C. Preinstallation Conference: Conduct conference at Project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Grace Construction Products.
3. Hilti, Inc.
6. NUCO Inc.
8. RectorSeal Corporation.
9. Specified Technologies Inc.
10. 3M Fire Protection Products.
12. USG Corporation.
2.2 PENETRATION FIRESTOPPING

A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
   1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
   1. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
   2. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

D. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.
   1. L-Rating: Not exceeding 5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m) of penetration opening at 0.30-inch wg (74.7 Pa) at both ambient and elevated temperatures.

E. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

F. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   1. Sealants: 250 g/L.
   2. Sealant Primers for Nonporous Substrates: 250 g/L.
   3. Sealant Primers for Porous Substrates: 775 g/L.

G. Low-Emitting Materials: Penetration firestopping sealants and sealant primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

H. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

C. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

D. Install fill materials for firestopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.2 IDENTIFICATION

A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.3 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections.
B. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.

C. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.4 PENETRATION FIRESTOPPING SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.

B. Where Intertek ETL SEMKO-listed systems are indicated, they refer to design numbers in Intertek ETL SEMKO’s "Directory of Listed Building Products" under "Firestop Systems."

C. Where FM Global-approved systems are indicated, they refer to design numbers listed in FM Global's "Building Materials Approval Guide" under "Wall and Floor Penetration Fire Stops."

END OF SECTION 07 84 13
SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Urethane joint sealants.
3. Latex joint sealants.
4. Preformed joint sealants.
5. Acoustical joint sealants.

B. Related Sections
1. Section 018113 – Sustainability Requirements

1.2 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For sealants and sealant primers used inside the weatherproofing system, documentation including printed statement of VOC content.

2. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

3. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regionally manufactured and regionally extracted and manufactured materials. Include statement indicating cost for each regionally manufactured material.
   a. Include statement indicating location of manufacturer and distance to Project for each regionally manufactured material.
   b. Include statement indicating location of manufacturer and point of extraction, harvest, or recovery for each raw material used in regionally extracted and manufactured materials. Indicate distance to Project and fraction by weight of each regionally manufactured material that is regionally extracted.

C. Samples: For each kind and color of joint sealant required.

D. Joint-Sealant Schedule: Include the following information:
1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
5. Joint sealant VOC content.

1.3 INFORMATIONAL SUBMITTALS
A. Product test reports.
B. Warranties.

1.4 QUALITY ASSURANCE
A. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.
B. Preinstallation Conference: Conduct conference at Project site.

1.5 WARRANTY
A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.
B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL
A. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   1. Architectural Sealants: 250 g/L.
   2. Sealant Primers for Nonporous Substrates: 250 g/L.
   3. Sealant Primers for Porous Substrates: 775 g/L.
B. Low-Emitting Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

1. Suitability for Immersion in Liquids. Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.

D. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

E. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

2.2 SILICONE JOINT SEALANTS

A. Mildew-Resistant Silicone Joint Sealant: ASTM C 920.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. BASF Building Systems.
   b. Dow Corning Corporation.
   c. GE Advanced Materials - Silicons.
   d. May National Associates, Inc.
   e. Pecora Corporation.
   f. Polymeric Systems, Inc.
   g. Schnee-Morehead, Inc.
   h. Sika Corporation; Construction Products Division.
   i. Tremco Incorporated.

2. Type: Single component (S).
3. Grade: nonsag (NS).

2.3 URETHANE JOINT SEALANTS

A. Urethane Joint Sealant: ASTM C 920.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. BASF Building Systems.
b. Bostik, Inc.
d. May National Associates, Inc.
e. Pacific Polymers International, Inc.
f. Pecora Corporation.
g. Polymeric Systems, Inc.
h. Schnee-Morehead, Inc.
i. Sika Corporation; Construction Products Division.
j. Tremco Incorporated.

2. Type: multicomponent (M).
3. Grade: nonsag (NS).

2.4 LATEX JOINT SEALANTS

A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. BASF Building Systems.
   b. Bostik, Inc.
   c. May National Associates, Inc.
   d. Pecora Corporation.
   e. Schnee-Morehead, Inc.
   f. Tremco Incorporated.

2.5 ACOUSTICAL JOINT SEALANTS

A. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Pecora Corporation.
   b. USG Corporation.
2.6 JOINT SEALANT BACKING

A. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) or Type B (bicellular material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

B. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.

2.7 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

1. Remove laitance and form-release agents from concrete.
2. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.
3.2 INSTALLATION

A. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

B. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.

F. Acoustical Sealant Installation: Comply with ASTM C 919 and with manufacturer's written recommendations.

G. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.3 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.

1. Joint Locations:
b. Control and expansion joints in stone flooring.
c. Control and expansion joints in brick flooring.
d. Control and expansion joints in tile flooring.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.


1. Joint Locations:
   a. Control and expansion joints on exposed interior surfaces of exterior walls.
   b. Perimeter joints of exterior openings where indicated.
   c. Tile control and expansion joints.
   d. Vertical joints on exposed surfaces of interior unit masonry or concrete walls and partitions.
   e. Joints on underside of plant-precast structural concrete beams and planks.
   f. Perimeter joints between interior wall surfaces and frames of interior doors, windows and elevator entrances.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

C. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Sealant Location:
   a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
   b. Tile control and expansion joints where indicated.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.


1. Joint Location:
   a. Acoustical joints where indicated.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 07 92 00
SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes hollow-metal work.

1.2 Related Sections
1. Section 018113 – Sustainability Requirements

1.3 DEFINITIONS
A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
   2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regionally manufactured and regionally extracted and manufactured materials. Include statement indicating cost for each regionally manufactured material.
      a. Include statement indicating location of manufacturer and distance to Project for each regionally manufactured material.
      b. Include statement indicating location of manufacturer and point of extraction, harvest, or recovery for each raw material used in regionally extracted and manufactured materials. Indicate distance to Project and fraction by weight of each regionally manufactured material that is regionally extracted.
C. Shop Drawings: Include elevations, door edge details, frame profiles, metal thicknesses, preparations for hardware, and other details.
D. Samples for Initial Selection: For units with factory-applied color finishes.
E. Samples for Verification: For each type of exposed finish required.
F. Schedule: Prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Product test reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amweld International, LLC.
2. Apex Industries, Inc.
3. Ceco Door Products; an Assa Abloy Group company.
4. Commercial Door & Hardware Inc.
5. Concept Frames, Inc.
6. Curries Company; an Assa Abloy Group company.
7. Custom Metal Products.
8. Daybar.
10. de La Fontaine Industries.
11. DKS Steel Door & Frame Sys. Inc.
12. Door Components, Inc.
13. Fleming-Baron Door Products.
15. Greensteel Industries, Ltd.
16. HMF Express.
17. Hollow Metal Inc.
22. LaForce, Inc.
23. Megamet Industries, Inc.
24. Mesker Door Inc.
25. Michbi Doors Inc.
26. MPI Group, LLC (The).
27. National Custom hollow Metal.
29. Philipp Manufacturing Co (The).
30. Pioneer Industries, Inc.
31. Premier Products, Inc.
32. Republic Doors and Frames.
33. Rocky Mountain Metals, Inc.
34. Security Metal Products Corp.
35. Shanahans Manufacturing Ltd.
36. Steelcraft; an Ingersoll-Rand company.
37. Steward Steel; Door Division.
38. Stiles Custom Metal, Inc.
39. Titan Metal Products, Inc.
40. Trillium Steel Doors Limited.
41. West Central Mfg. Inc.

2.2 REGULATORY REQUIREMENTS

A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

B. Fire-Rated, Borrowed-Light Assemblies: Complying with NFPA 80 and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

2.3 INTERIOR DOORS AND FRAMES


1. Physical Performance: Level C according to SDI A250.4.
2. Doors:
   a. Type: As indicated in the Door and Frame Schedule.
   b. Thickness: 1-3/4 inches (44.5 mm).
   c. Face: Uncoated, cold-rolled steel sheet, minimum thickness of 0.032 inch (0.8 mm).
   d. Edge Construction: Model 1, Full Flush.
   e. Core: Manufacturer's standard.
3. Frames:
   a. Materials: Uncoated, cold-rolled steel sheet, minimum thickness of 0.042 inch (1.0 mm).
   b. Construction: Full profile welded.
5. At masonry wall locations, back prime the frame with black asphaltic mastic to prevent rust.
6. Reinforce all doors and frames at head location for door closer installation. This is for all locations regardless if a closer is specified.

2.4 FRAME ANCHORS

A. Jamb Anchors:
   1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch (1.0 mm) thick, with corrugated or perforated straps not less than 2 inches (51 mm) wide by 10 inches (254 mm) long; or wire anchors not less than 0.177 inch (4.5 mm) thick.
   2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch (1.0 mm) thick.
   3. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
   4. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch-(9.5-mm-) diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch (1.0 mm), and as follows:
   1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
   2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch (51-mm) height adjustment. Terminate bottom of frames at finish floor surface.

2.5 MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

D. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.

E. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.
   1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

F. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
G. Power-Actuated Fasteners in Concrete: From corrosion-resistant materials.

H. Grout: ASTM C 476, except with a maximum slump of 4 inches (102 mm), as measured according to ASTM C 143/C 143M.

I. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing).

J. Glazing: Section 08 80 00 "Glazing."

K. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat.

2.6 FABRICATION

A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Hollow-Metal Doors:

1. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
2. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated.

C. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
4. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
5. Jamb Anchors: Provide number and spacing of anchors as follows:
   a. Masonry Type: Locate anchors not more than 16 inches (406 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c., to match coursing, and as follows:
      1) Two anchors per jamb up to 60 inches (1524 mm) high.
      2) Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
      3) Four anchors per jamb from 90 to 120 inches (2286 to 3048 mm) high.
4) Four anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 120 inches (3048 mm) high.

b. Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:

1) Three anchors per jamb up to 60 inches (1524 mm) high.
2) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
3) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) high.
4) Five anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 96 inches (2438 mm) high.

c. Compression Type: Not less than two anchors in each frame.

d. Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.

6. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers.

a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

D. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

E. Stops and Moldings: Provide stops and moldings around glazed lites and louvers where indicated. Form corners of stops and moldings with mitered hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow-metal work.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
4. Provide loose stops and moldings on inside of hollow-metal work.
5. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

2.7 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Hollow-Metal Frames: Install hollow-metal frames of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
   a. At fire-rated openings, install frames according to NFPA 80.
   b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
   c. Install frames with removable stops located on secure side of opening.
   d. Install door silencers in frames before grouting.
   e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
   f. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
   g. Field apply bituminous coating to backs of frames that will be filled with grout OR any exterior frames.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
   a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.


4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.

5. Concrete Walls: Solidly fill space between frames and concrete with mineral-fiber insulation.

6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

7. In-Place Metal or Wood-Stud Partitions: Secure slip-on drywall frames in place according to manufacturer's written instructions.

8. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
   a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

B. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Steel Doors:
   a. Between Door and Frame Jambs and Head: 1/8 inch (3.2 mm) plus or minus 1/32 inch (0.8 mm).
   b. Between Edges of Pairs of Doors: 1/8 inch (3.2 mm) to 1/4 inch (6.3 mm) plus or minus 1/32 inch (0.8 mm).
   c. At Bottom of Door: [3/4 inch (19.1 mm)] [5/8 inch (15.8 mm)] plus or minus 1/32 inch (0.8 mm).
   d. Between Door Face and Stop: 1/16 inch (1.6 mm) to 1/8 inch (3.2 mm) plus or minus 1/32 inch (0.8 mm).

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
3. Smoke-Control Doors: Install doors and gaskets according to NFPA 105.

C. Glazing: Comply with installation requirements in Section 08 80 00 "Glazing" and with hollow-metal manufacturer's written instructions.

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (51 mm) o.c. from each corner.

3.2 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow-metal work immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

E. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid-core doors with wood-veneer faces.
2. Factory finishing flush wood doors.
3. Factory fitting flush wood doors to frames and factory machining for hardware.

B. Related Requirements:

1. Section 088000 "Glazing" for glass view panels in flush wood doors.
2. Section 018113 – Sustainability Requirements

1.2 ACTION SUBMITTALS

A. Product Data: For each type of door.

B. LEED Submittals:

1. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regionally manufactured and regionally extracted and manufactured materials. Include statement indicating cost for each regionally manufactured material.
   a. Include statement indicating location of manufacturer and distance to Project for each regionally manufactured material.

2. Certificates for Credit MR 7: Chain-of-custody certificates indicating that flush wood doors comply with forest certification requirements.[ Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. ] Include statement indicating cost for each certified wood product.
3. Product Data for Credit IEQ 4.4: For adhesives and composite wood products, documentation indicating that product contains no urea formaldehyde.

C. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:

1. Dimensions and locations of blocking.
2. Dimensions and locations of mortises and holes for hardware.
3. Dimensions and locations of cutouts.
4. Undercuts.
5. Requirements for veneer matching.
6. Doors to be factory finished and finish requirements.
7. Fire-protection ratings for fire-rated doors.

D. Samples: For factory-finished doors.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Algoma Hardwoods, Inc.
2. Ampco.
3. Chappell Door Co.
4. Eggers Industries.
5. General Veneer Manufacturing Co.
7. Haley Brothers, Inc.
8. Ipik Door Company.
10. Marlite.
11. Marshfield Door Systems, Inc.
12. Mohawk Doors; a Masonite company.
15. Vancouver Door Company.
16. VT Industries, Inc.

2.2 FLUSH WOOD DOORS, GENERAL

A. Quality Standard: In addition to requirements specified, comply with AWI's, "Architectural Woodwork Standards."

1. Provide AWI Quality Certification Labels indicating that doors comply with requirements of grades specified.
B. Regional Materials: Flush wood doors shall be manufactured within 500 miles (800 km) of Project site.

C. Certified Wood: Flush wood doors shall be certified as "FSC Pure" according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and to FSC STD-40-004, "FSC Standard for Chain of Custody Certification."

D. Low-Emitting Materials: Fabricate doors with adhesives and composite wood products that do not contain urea formaldehyde.

E. WDMA I.S.1-A Performance Grade:
   1. Heavy Duty unless otherwise indicated.
   2. Extra Heavy Duty: Classrooms, public toilets, janitor's closets, assembly spaces and exits.
   3. Standard Duty: Closets (not including janitor's closets) and private toilets.

F. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
   1. Cores: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
   2. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
   3. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.

G. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control, based on testing according to UL 1784.

H. Particleboard-Core Doors:
   1. Particleboard: ANSI A208.1, Grade LD-2, made with binder containing no urea-formaldehyde.
   2. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.
   3. Provide doors with [glued-wood-stave] [or] [structural-composite-lumber] cores instead of particleboard cores for doors indicated to receive exit devices.

I. Structural-Composite-Lumber-Core Doors:
      a. Screw Withdrawal, Face: 700 lbf (3100 N).
      b. Screw Withdrawal, Edge: 400 lbf (1780 N).

J. Mineral-Core Doors:
1. **Core:** Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.

2. **Blocking:** Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.

3. **Edge Construction:** At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

2.3 **VENEER-FACED DOORS FOR TRANSPARENT FINISH**

   **A. Interior Solid-Core Doors:**

   1. **Grade:** Premium, with Grade A faces.
   2. **Species:** Maple.
   3. **Cut:** Plain sliced (flat sliced).
   4. **Match between Veneer Leaves:** Book or Slip match.
   5. **Assembly of Veneer Leaves on Door Faces:** Running match.
   6. **Pair and Set Match:** Provide for doors hung in same opening or separated only by mullions.
   7. **Core:** Either glued wood stave or structural composite lumber.
   8. **Construction:** Five plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering.

2.4 **LIGHT FRAMES**

   **A. Metal Frames:** Manufacturer's standard frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish; and approved for use in doors of fire-protection rating indicated.

2.5 **FABRICATION**

   **A. Factory fit doors to suit frame-opening sizes indicated.** Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.

   1. Comply with NFPA 80 requirements for fire-rated doors.

   **B. Factory machine doors for hardware that is not surface applied.**

   **C. Openings:** Factory cut and trim openings through doors.

   1. **Light Openings:** Trim openings with moldings of material and profile indicated.
   2. **Glazing:** Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."
2.6 FACTORY FINISHING

A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.

1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.

B. Factory finish doors that are indicated to receive transparent finish.

C. Transparent Finish:

1. Grade: Premium.
2. Finish: AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" System 11, catalyzed polyurethane.
3. Staining: As selected by Architect from manufacturer's full range.
4. Effect: Open-grain finish.
5. Sheen: Satin.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Hardware: For installation, see Section 087100 "Door Hardware.

B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.

1. Install fire-rated doors according to NFPA 80.
2. Install smoke- and draft-control doors according to NFPA 105.

C. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.

1. Clearances: Provide 1/8 inch (3.2 mm) at heads, jambs, and between pairs of doors. Provide 1/8 inch (3.2 mm) from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch (6.4 mm) from bottom of door to top of threshold unless otherwise indicated.

   a. Comply with NFPA 80 for fire-rated doors.

D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

E. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.
END OF SECTION 081416
SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Access doors and frames for walls and ceilings.

B. Related Sections:
   1. Section 018113 – Sustainability Requirements

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each door face material.

D. Schedule: Types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 tested according to the following test method:
   1. NFPA 252 or UL 10B for fire-rated access door assemblies installed vertically.
   2. NFPA 288 for fire-rated access door assemblies installed horizontally.

2.2 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Access Panel Solutions.
   2. Acudor Products, Inc.
   3. Alfab, Inc.
   4. Babcock-Davis.
   5. Cendrex Inc.
7. Jensen Industries; Div. of Broan-Nutone, LLC.
11. Maxam Metal Products Limited.
12. Metropolitan Door Industries Corp.
13. MIFAB, Inc.
14. Milcor Inc.
15. Nystrom, Inc.

B. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.


D. Flush Access Doors with Concealed Flanges:
   1. Assembly Description: Fabricate door to fit flush to frame. Provide frame with beads for concealed flange installation.
   2. Locations: Wall and ceiling.
   3. Door Size: 16” x 16”
   4. Steel Sheet for Door: Nominal 0.064 inch (1.63 mm), 16 gage
      a. Finish: Stainless Steel
   5. Frame Material: Same material and thickness as door.
   7. Hardware: Latch with torx/hex head locking device.

2.3 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

C. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.

D. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.


G. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than strength and durability properties of Alloy 5005-H15; with minimum sheet thickness according to ANSI H35.2 (ANSI H35.2M).

H. Frame Anchors: Same type as door face.

I. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.4 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.

D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling.

E. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.

   1. For cylinder locks, furnish two keys per lock and key all locks alike.
   2. For recessed panel doors, provide access sleeves for each locking device. Furnish plastic grommets and install in holes cut through finish.

F. Extruded Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.

2.5 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
D. Steel and Metallic-Coated-Steel Finishes:
   1. Factory Prime: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

E. Aluminum Finishes:
   1. Mill finish.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Comply with manufacturer's written instructions for installing access doors and frames.
   B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.2 ADJUSTING
   A. Adjust doors and hardware, after installation, for proper operation.
   B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 083113
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. All provisions of the Contract Documents apply to this Section. The Contractor for this Section shall be responsible for complete familiarity with same.

1.2 SUMMARY
A. Section Includes:
1. Exterior and interior storefront framing.
2. Exterior and interior manual-swing and automatic swing entrance doors and door frame units.
3. Coordination with the Electrical Contractor for the rough-in requirements for the door access controls.
B. Related Sections:
1. Section 018113 – Sustainability Requirements

1.3 PERFORMANCE REQUIREMENTS
A. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:
1. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
2. Dimensional tolerances of building frame and other adjacent construction.
3. Failure includes the following:
   a. Deflection exceeding specified limits.
   b. Thermal stresses transferring to building structure.
   c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
   d. Noise or vibration created by wind and by thermal and structural movements.
   e. Loosening or weakening of fasteners, attachments, and other components.
   f. Failure of operating units.
B. Wind Loads: 20/PSF.
C. Deflection of Framing Members:
1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane shall not exceed L/175 of the glass edge length for each individual glazing lite.

2. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller.

D. Structural-Test Performance: Provide aluminum-framed systems tested according to the following:
   1. Resistance to corner racking shall be tested by the Dual Moment Load test as follows:
      a. Test section shall consist of a standard top door corner assembly. Side rail section shall be 24” long and top rail section shall be 12” long.
      b. Anchor “top rail” positively to test bench so that corner protrudes 3” beyond bench edge.
      c. Anchor a lever arm positively to “side rail” at a point 19” from inside edge of “top rail”. Attach weight support pad at a point 19” from inner edge of “side rail”.
      d. Test section shall withstand a load of 270 pounds on the lever arm before reaching the point of failure, which shall be considered a rotation of the lever arm in excess of 45°.

E. Air Infiltration shall be tested in accordance with ASTM E 283, at a pressure differential of 1.567 P.S.F. (75 Pa). A single 3’-0” x 7’-0” entrance door and frame shall not exceed .20 CFM per linear foot of perimeter crack. A pair of 6’-0” x 7’-0” entrance doors and frame shall not exceed 1.0 cfm per linear foot of perimeter crack.

F. Water Penetration under Static Pressure: Provide aluminum-framed systems that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).

1.4 SUBMITTALS

A. Product Data: Submit manufacturer’s specifications, certified test data, installation instructions, general recommendations, and Material Safety Data Sheets for all materials. Include data substantiating that the materials are recommended for the intended application by the manufacturer. These submittals shall:
   1. For each element of the work that meets the specified requirements of the work, without exception, the submission is for general information only.
   2. For any element of the work that varies, in any way, from the specified requirements of the work, Contractor shall highlight the extent of variance on the submittal. Architect’s review shall be limited to the variance as highlighted.

B. Shop Drawings: Submit only shop drawings as listed below. Architect shall limit review to ONLY the elements listed below; regardless of inclusion of additional
items with the required shop drawings, the Contractor shall have total responsibility for the correctness of such additional submittal:

1. Methods of joinery of components.
2. Connection details of aluminum entrance assemblies to adjoining work.
3. Include details of provisions for system expansion system expansion and contraction and for drainage of moisture in the system to the exterior.

C. Samples: Color samples indicating range of color and finish texture for each type of exposed finish required.

D. Product test reports.

E. Maintenance data.

F. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.

C. Engineering Responsibility: Prepare data for aluminum-framed systems, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in systems similar to those indicated for this Project.

D. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.


F. Source Limitations for Aluminum-Framed Systems: Obtain from single source from single manufacturer.

G. Preinstallation Conference: Conduct conference at Project site.

H. Schedule a preinstallation meeting with the Electrical and Division 08 71 00 Contractors to review the rough-in requirements for the electrical raceways, junction boxes and wiring for the Door Access Controls including, but not limited to, the following:
2.
   a. Automatic door operators.
   b. Automatic door remote actuator push buttons.
   c. Electronic door hardware.
   d. Door position sensor / contacts.
   e. Access card readers.
   f. Exit lights.
   g. Additional electrical raceways, junction boxes and wiring, not listed above, that are required to be installed within the framing system provided by this contractor (Section 084113).
   h.

3. The preinstallation meeting needs to include the method and timing / schedule for the installation of the electrical raceways, junction boxes and wiring that are required to be installed within the framing system provided by this contractor (Section 084113).

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
   1. Submit written guarantees signed by Manufacturer and Installer agreeing to replace aluminum doors, frames, and window units which fail under normal use in materials or workmanship within three (3) years of date of Contract Completion Certificate. Failure of materials or workmanship shall include, but not be limited to, excessive leakage or air infiltration, excessive deflections, faulty operation, deterioration of finish or metal in excess of normal weathering, and defects in hardware, weatherstripping, and other components of the installation.

B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes do not comply with requirements or that fail in materials or workmanship within specified warranty period. Warranty does not include normal weathering.
   1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the following:
   1. Aluminum doors/frames specified and detailed on construction documents represent Oldcastle series as noted below. ALL areas are to be FRONT SET glazing.
   2. Doors shall be Oldcastle PerforMax Wide Stile Doors.
3. Storefront and Exterior Window frames shall be Oldcastle Series 3000 Thermal Multiplane.

B. Or provide comparable products by one of the following:
   1. EFCO Corporation
   2. Kawneer
   3. YKK AP America Inc.

2.2 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
   2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 & ASTM B211.
   4. Structural Profiles: ASTM B 308/B 308M.
   5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
   1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
   2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
   3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.
      a. EFCO Corporation
      b. Tubelight Architectural Systems
      c. CMI Architectural Products
      d. Curtainwall Systems
      e. YKK AP America Inc.
      f. Vistawall Architectural Products

2.3 FRAMING SYSTEMS

A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
   1. Construction: Nonthermal (at interior locations) and Thermally broken (at exterior locations).
   2. Glazing System: Retained mechanically with gaskets on four sides.

B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.
3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.

D. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts, complying with ASTM A 123/A 123M or ASTM A 153/A 153M.

E. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials. All exposed surfaces shall be finished to match the adjacent aluminum framing material.

F. Framing System Gaskets and Sealants: Manufacturer's standard, recommended by manufacturer for joint type.
   1. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 GLAZING SYSTEMS

A. Glazing: As specified in Division 08 Section "Glazing."

B. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.

C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.

D. INSULATED METAL INFILL PANELS:
   A. Insulated Metal Infill Panels shall be equal to
      a. Omega Foam Ply panels as manufactured by Laminators, Inc. 3255 Souderton Pike Hatfield, PA 19440, 1-800-523-2347
      b. Mapes Industries, Inc. 2929 Cornhusker Hwy. PO Box 80069 (68501) Lincoln, NE 68504, 800-228-2391
      c. Citadel Architectural Products, 3131A North Franklin Road, Indianapolis, IN 46226, (800) 466-8828.
   B. Insulated Metal Infill Panels construction shall be constructed as follows:
      1. 0.032 Aluminum face sheet with kynar color to be selected by Architect to match selected Plastic Wall Panel colors. This may result in a custom color selection. All exposed surfaces to have color/texture selected by architect (interior of some panels is exposed).
      2. 1/8” thick tempered hardboard with stabilizer
      3. Polystyrene insulated foam core (Class A, under 25 flame spread)
      4. 1/8” thick tempered hardboard with stabilizer
C. Total Panel thickness shall be 1” to fit exterior window framing system.

D. Location / Size: See Drawings and coordinate opening locations and sizes with other trades as required.

2.5 ENTRANCE DOOR SYSTEMS

A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.
   1. Door Construction: 2-inch (50.8-mm) overall thickness, with minimum 0.188-inch- (4.8-mm-) thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
      a. Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.
   2. Door Design: Wide stile; 5-inch (127-mm) nominal width.
      a. Provide nonremovable glazing stops on outside of door.

B. Entrance Door Hardware: Provided and installed by this contractor and as specified in Division 08 Section "Door Hardware."

2.6 ENTRANCE DOOR HARDWARE

A. The following Entrance Door Hardware is provided and installed by this contractor and is in addition to the hardware specified in Division 8 Section “Door Hardware”:

B. Weather Stripping: Manufacturer's standard replaceable components.

C. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.

D. Silencers: BHMA A156.16, Grade 1.

E. Thresholds: BHMA A156.21, raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch (13 mm).

F. Butt Hinges: BHMA A156.1, Grade 1, radius corner.
   1. Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while entrance door is closed.
   2. Exterior Hinges: Stainless steel, with stainless-steel pin
   3. Quantities:
a. For doors up to 87 inches (2210 mm) high, provide three hinges per leaf.
b. For doors more than 87 and up to 120 inches (2210 and up to 3048 mm) high, provide four hinges per leaf.

G. Continuous-Gear Hinges: Manufacturer's standard with stainless-steel bearings between knuckles, fabricated to full height of door and frame.

H. Operating Trim: BHMA A156.6.

I. Removable Mullions: BHMA A156.3, extruded aluminum.
   1. When used with panic exit devices, provide removable mullions listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305. Use only mullions that have been tested with exit devices to be used.

J. Drip Cap: Manufacturer’s Standard, full width of door opening.

K. Additional hardware not listed above, or specified in Division 8 Section “Door Hardware”, but is required for a complete and operational aluminum entrance installation.

L. ALL hardware to match door and framing finish color

2.7 ACCESSORY MATERIALS

A. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil (0.762-mm) thickness per coat.

2.8 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
   1. Profiles that are sharp, straight, and free of defects or deformations.
   2. Accurately fitted joints with ends coped or mitered.
   3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
   4. Physical and thermal isolation of glazing from framing members.
   5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
6. Provisions for field replacement of glazing from interior for vision glass and exterior for spandrel glazing or metal panels.
7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.

F. Entrance Doors: Reinforce doors as required for installing entrance door hardware.

G. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

H. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.9 ALUMINUM FINISHES

A. High-Performance Organic Finish: Three-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

1. Color and Gloss: As selected by Architect from manufacturer's full range (black is preliminary selection)

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
6. Seal joints watertight unless otherwise indicated.
7. Coordinate delivery and installation with other trades.
8. All measurements shall be taken at the site before starting work. Notify General Contractor of conditions which will affect the quality of installation.
9. Provide for expansion and contraction as required to avoid damage to units.
10. Clean surfaces promptly after installation. Exercise care to avoid damage to coatings and finishes. Remove excess glazing and sealant compounds, dirt and other substances. Protect all work until contract completion.

11. Coordinate the method and timing/schedule for the installation of the electrical raceways, junction boxes and wiring that are required to be installed within the framing system provided by this contractor (Section 084113).

B. Metal Protection:
   1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
   2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

D. Set continuous sill members and flashing in full sealant bed as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.

E. Install components plumb and true in alignment with established lines and grades, and without warp or rack.

F. Install glazing as specified in Division 08 Section "Glazing."

G. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.
   1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
   2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.2 FIELD QUALITY CONTROL

A. The following field testing is included in the Contractor’s scope of work. The Contractor shall perform the following field testing:
   1. Water Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
      a. Test Area: A minimum area of 75 feet (23 m) by 1 story of aluminum-framed systems.

B. Repair or remove work if test results and inspections indicate that it does not comply with specified requirements.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
D. Aluminum-framed assemblies will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 08 41 13
PART 1 - GENERAL

1.1 SUMMARY

A. Section includes exterior, and interior sliding, power-operated automatic entrances.

B. Related Sections:
   1. Section 018113 – Sustainability Requirements

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For automatic entrances.
   1. Include plans, elevations, sections, hardware mounting heights, and attachment details.
   2. Include diagrams for power, signal, and control wiring.
   3. Indicate locations of activation and safety devices.
   4. Include hardware schedule and indicate hardware types, functions, quantities, and locations.

C. Sample: For each exposed product and for each color and texture specified.

D. Delegated-Design Submittal: For automatic entrances.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation and maintenance of units required for this Project.

B. Certified Inspector Qualifications: Certified by AAADM.
1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of automatic entrances that fail in materials or workmanship within specified warranty period.

   1. Warranty Period: On hold two years from date of Substantial Completion.

B. Special Finish Warranty: Manufacturer agrees to repair or replace components on which finishes fail in materials or workmanship within specified warranty period.

   1. Deterioration includes, but is not limited to, the following:

      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

   2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 AUTOMATIC ENTRANCE ASSEMBLIES

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Power-Operated Door Standard: BHMA A156.10.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design automatic entrances.

B. Wind Loads: Per structural drawings.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

D. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 1.25 cfm/sq. ft. of fixed entrance-system area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 1.57 lbf/sq. ft.
2.3 SLIDING AUTOMATIC ENTRANCES

A. General: Provide manufacturer's standard automatic entrances including doors, sidelites, framing, headers, carrier assemblies, roller tracks, door operators, controls, and accessories required for a complete installation.

B. All-Glass Sliding Automatic Entrance:

1. Manufacturers: Subject to compliance with requirements, basis of design is Besam SL 500 provide products by one of the following:
   a. Biparting-Sliding Units:
      1) Besam Entrance Solutions; Subsidiary of ASSA ABLOY Entrance Systems.
      2) DORMA Automatics; Division of DORMA Group North America.
      3) Gildor Automatic Doors.
      4) Horton Automatics; a division of Overhead Door Corporation.
      5) Hunter Automatics Inc.
      6) Nabco Entrances Inc.
      7) record-usa.
      8) Stanley Access Technologies, LLC; Division of Stanley Security Solutions.
      9) Tormax Technologies, Inc.

2. Configuration: Biparting-sliding door(s) with sidelite(s).
   a. Traffic Pattern: One way.
   b. Emergency Breakaway Capability: Sliding leaves only
   c. Mounting: Between jambs.

3. Operator Features:
   a. Power opening and closing.
   b. Drive System: Chain or belt.
   c. Adjustable opening and closing speeds.
   d. Adjustable hold-open time between zero and 30 seconds.
   e. Obstruction recycle.
   f. On-off/hold-open switch to control electric power to operator tied to building controls systems.

4. Sliding-Door Carrier Assemblies and Overhead Roller Tracks: Carrier assembly that allows vertical adjustment; consisting of nylon- or delrin-covered, ball-bearing-center steel wheels operating on a continuous roller track, or ball-bearing-center steel wheels operating on a nylon- or delrin-covered, continuous roller track. Support doors from carrier assembly by cantilever and pivot assembly.
   a. Rollers: Minimum of two ball-bearing roller wheels and two antirise rollers for each active leaf.

5. Sliding-Door Threshold: Threshold members and bottom-guide-track system with stainless-steel, ball-bearing-center roller wheels.
a. Configuration: No threshold across door opening and recessed guide-track system at sidelites.

6. Controls: Activation and safety devices according to BHMA standards.
   a. Activation Device: Motion sensor mounted on each side of door header to detect pedestrians in activating zone to activate door operator.
   b. Safety Device: Presence sensor mounted on each side of door header and two photoelectric beams mounted in sidelite jambs on one side of the door to detect pedestrians in presence zone and to prevent door from closing.
   c. Sidelite Safety Device: Presence sensor, mounted above each sidelite on side of door opening through which doors travel, to detect obstructions and to prevent door from opening.

7. Finish: Finish framing, door(s), and header with finish matching adjacent storefront.

2.4 ENTRANCE COMPONENTS

A. Framing Members: Extruded aluminum, minimum 0.125 inch thick and reinforced as required to support imposed loads.
   1. Nominal Size: 1-3/4 by 4-1/2 inches Retain "Extruded Glazing Stops and Applied Trim" Subparagraph below for separately framed sidelites or transoms.
   2. Extruded Glazing Stops and Applied Trim: Minimum 0.062-inch wall thickness.

B. Stile and Rail Doors: 1-3/4-inch- (45-mm-) thick, glazed doors with minimum 0.125-inch- (3.2-mm-) thick, extruded-aluminum tubular stile and rail members. Mechanically fasten corners with reinforcing brackets that are welded, or incorporate concealed tie-rods that span full length of top and bottom rails.
   2. Stile Design: Medium stile, 3-1/2-inch nominal width Last option in "Rail Design" Subparagraph below is required for manual doors along an accessible route but is not required for automatic doors.
   3. Rail Design: 5-inch nominal height retain "Muntin Bars" Subparagraph below if required. Many manufacturers include muntins as standard.
   4. Muntin Bars: Horizontal tubular rail member for each door; match stile design and finish.

C. All-Glass Sliding Doors: Fabricated from 13-mm-thick tempered glass, with polished vertical edges and minimum 0.125-inch thick, extruded-aluminum top and bottom rails.
   1. Rail Design: 5-inch nominal height.

D. Side lights: 1-3/4-inch deep sidelights with minimum 0.125-inch thick, extruded-aluminum tubular stile and rail members matching door design.
   1. Glazing Stops and Gaskets: Same materials and design as for stile and rail door.
   2. Glazing Stops and Gaskets: Snap-on, extruded-aluminum stops and preformed gaskets.
3. Muntin Bars: Horizontal tubular rail members for each sidelite; match stile design.

E. Headers: Fabricated from minimum 0.125-inch thick extruded aluminum and extending full width of automatic entrance units to conceal door operators and controls. Provide hinged or removable access panels for service and adjustment of door operators and controls. Secure panels to prevent unauthorized access.

   1. Mounting: Concealed, with one side of header flush with framing.

F. Signage: As required by cited BHMA standard.

   1. Application Process: Door manufacturer's standard process.

2.5 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.


B. Steel Reinforcement: Reinforcement with corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Use surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.

C. Stainless-Steel Bars: ASTM A 276 or ASTM A 666, Type 304.

D. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.

E. Expanded Aluminum Mesh: Expanded aluminum sheet according to the geometry of ASTM F 1267.

F. Polycarbonate Sheet: ASTM C 1349, Appendix X1, Type II, coated, mar-resistant, UV-stabilized polycarbonate with coating on both surfaces.

G. Glazing: As specified in Section 088000 "Glazing."

H. Sealants and Joint Fillers: As specified in Section 079200 "Joint Sealants."

I. Nonmetallic, Shrinkage-Resistant Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout; complying with ASTM C 1107/C 1107M; of consistency suitable for application.

J. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

K. Fasteners and Accessories: Corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
2.6 DOOR OPERATORS AND CONTROLS

A. General: Provide operators and controls, which include activation and safety devices, according to BHMA standards, for condition of exposure, and for long-term, maintenance-free operation under normal traffic load for type of occupancy indicated.

B. Door Operators: Provide door operators of size recommended by manufacturer for door size, weight, and movement.
   1. Door Operator Performance: Door operators shall open and close doors and maintain them in fully closed position when subjected to Project's design wind loads.
   2. Electromechanical Operators: Concealed, self-contained, overhead unit powered by fractional-horsepower, permanent-magnet dc motor; with closing speed controlled mechanically by gear train and dynamically by braking action of electric motor; with solid-state microprocessor controller; UL 325; and with manual operation with power off.

C. Presence Sensors: Self-contained, active-infrared scanner units; adjustable to provide detection-field sizes and functions required by BHMA A156.10. Sensors shall remain active at all times.

D. Electrical Interlocks: Unless units are equipped with self-protecting devices or circuits, provide electrical interlocks to prevent activation of operator when door is locked, latched, or bolted.

E. Mode Selector Control – allow the following functions:
   1. Off
   2. Exit Only - one way traffic with automatic operation from the interior
   3. Two way traffic – allowing automatic operation from exterior and interior
   4. Partial Opening – energy saving option allows door to automatically adjust opening width based on amount of usage, full open during high use and partial opening during low use. The control for this setting shall be programmable allowing adjustment to both the usage and opening settings.
   5. Hold Open – doors activated and held in the full open position.

2.7 HARDWARE

A. General: Provide units in sizes and types recommended by automatic entrance and hardware manufacturers for entrances and uses indicated. Finish exposed parts to match door finish.

B. Breakaway Device for Power-Operated Doors: Device that allows door to swing out in direction of egress to full 90 degrees from any operating position. Interrupt powered operation of door operator while in breakaway mode.

C. Deadlocks: Deadbolt operated by exterior cylinder and interior thumb turn, with minimum 1-inch long throw bolt; BHMA A156.5, Grade 1.
   1. Cylinders: As specified in Section 087100 "Door Hardware”.
      a. Keying: Integrate into building master key system.
   2. Deadbolts: Steel, mortise type, BHMA A156.5, Grade 1.
3. Two-Point Locking for Stile and Rail Sliding Doors: Mechanism in stile of active door leaf that automatically extends second lockbolt into threshold.

D. Dustproof Strikes for All-Glass Sliding Doors: Recessed, floor-type, BHMA A156.16, Grade 1, to receive deadbolt.

E. Weather Stripping: Replaceable components.
   1. Sliding Type: AAMA 701, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

2.8 FABRICATION

A. General: Factory fabricate automatic entrance components to designs, sizes, and thicknesses indicated and to comply with indicated standards.

B. Framing: Provide automatic entrances as prefabricated assemblies. Complete fabrication, assembly, finishing, hardware application, and other work before shipment to Project site.
   1. Provide components with concealed fasteners and anchor and connection devices.
   2. Fabricate components with accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion.
   3. Fabricate exterior components to drain condensation and water passing joints within system to the exterior.
   4. Provide anchorage and alignment brackets for concealed support of assembly from building structure.
   5. Allow for thermal expansion of exterior units.

C. Doors: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.

D. Door Operators: Factory fabricated and installed in headers, including adjusting and testing.

E. Glazing: Fabricate framing with minimum glazing edge clearances for thickness and type of glazing indicated, according to GANA's "Glazing Manual."

F. Hardware: Factory install hardware to greatest extent possible; remove only as required for final finishing operation and for delivery to and installation at Project site. Cut, drill, and tap for factory-installed hardware before applying finishes.
   1. Provide sliding-type weather stripping, mortised into door, at perimeter of doors and breakaway sidelites.

G. Controls:
   1. General: Factory install activation and safety devices in doors and headers as required by BHMA A156.10 for type of door and direction of travel.
2.9 ALUMINUM FINISHES

A. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install automatic entrances according to manufacturer's written instructions and cited BHMA standard for direction of pedestrian travel, including signage, controls, wiring, and connection to the building's power supply.

1. Do not install damaged components. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure nonmovement joints. Seal joints watertight.
2. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
3. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous coating.

B. Entrances: Install automatic entrances plumb and true in alignment with established lines and grades without warp or rack of framing members and doors. Anchor securely in place.

1. Install surface-mounted hardware using concealed fasteners to greatest extent possible.
2. Set headers, carrier assemblies, tracks, operating brackets, and guides level and true to location with anchorage for permanent support.
3. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within system to exterior.
4. Level recesses for recessed thresholds using nonshrink grout.

C. Door Operators: Connect door operators to electrical power distribution system.

D. Access-Control Devices: Connect access-control devices to access-control system as specified in Section 281300 "Access Control."

E. Controls: Install and adjust activation and safety devices according to manufacturer's written instructions and cited BHMA standard for direction of pedestrian travel. Connect control wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Glazing: Install glazing as specified in Section 088000 "Glazing."

G. Sealants: Comply with requirements specified in Section 079200 "Joint Sealants" to provide weathertight installation.
1. Set thresholds, bottom-guide-track system, framing members and flashings in full sealant bed.
2. Seal perimeter of framing members with sealant.

H. Signage: Apply signage on both sides of each door and breakaway sidelite as required by cited BHMA standard for direction of pedestrian travel.

I. Wiring within Automatic Entrance Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's written limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 FIELD QUALITY CONTROL

A. Certified Inspector: Engage a Certified Inspector to test and inspect components, assemblies, and installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

   1. Test and inspect each automatic entrance, using AAADM inspection forms, to determine compliance of installed systems with applicable BHMA standards.

C. Automatic entrances will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.3 ADJUSTING

A. Adjust hardware, moving parts, door operators, and controls to function smoothly, and lubricate as recommended by manufacturer; comply with requirements of applicable BHMA standards.

B. Readjust door operators and controls after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles).

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain automatic entrances.

END OF SECTION 084229.23
SECTION 084423 - STRUCTURAL-SEALANT-GLAZED CURTAIN WALLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Field-glazed, two-sided structural-sealant-glazed curtain-wall assemblies.

B. Related Sections
   1. Sections 018113 – Sustainability requirements

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:
   1. Product Data: For sealants, indicating VOC content.
   2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Include plans, elevations, sections, full-size details, and attachments to other work.
   1. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

D. Samples: For each exposed finish required.

E. Delegated-Design Submittal: For structural-sealant-glazed curtain walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Energy Performance Certificates: NFRC-certified energy performance values from manufacturer.
B. Product test reports.

C. Quality-Control Program: Developed specifically for Project, including fabrication and installation, according to recommendations in ASTM C 1401. Include periodic quality-control reports.

D. Source quality-control reports.

E. Field quality-control reports.

F. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025.

C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

D. Structural-Sealant Glazing: Comply with ASTM C 1401 for design and installation of curtain-wall assemblies.

1.7 WARRANTY

A. Special Warranty: Installer agrees to repair or replace components of glazed aluminum curtain wall that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed entrances and storefronts.

B. General Performance: Comply with performance requirements specified, as determined by testing of structural-sealant-glazed curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Structural-sealant-glazed curtain walls shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.

2. Failure also includes the following:
   a. Thermal stresses transferring to building structure.
   b. Glass breakage.
   c. Noise or vibration created by wind and thermal and structural movements.
   d. Loosening or weakening of fasteners, attachments, and other components.
   e. Failure of operating units.

C. Structural Loads:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings

D. Deflection of Framing Members: At design wind pressure, as follows:

1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19.1 mm), whichever is less.

2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller
   a. Operable Units: Provide a minimum 1/16-inch (1.6-mm) clearance between framing members and operable units.

3. Cantilever Deflection: Where framing members overhang an anchor point, as follows:
   a. Perpendicular to Plane of Wall: No greater than 1/240 of clear span plus 1/4-inch (6.35-mm) for spans greater than 11 feet 8-1/4 inches (3.6 m) or 1/175 times span, for spans less than 11 feet 8-1/4 inches (3.6 m).
E. Structural: Test according to ASTM E 330 as follows:

1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:

1. Fixed Framing and Glass Area:
   a. Maximum air leakage of 0.06 cfm/sq. ft. (0.30 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa)

G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa)

H. Energy Performance: Certify and label energy performance according to NFRC as follows:

1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.45 Btu/sq. ft. x h x deg F (2.55 W/sq. m x K as determined according to NFRC 100.
2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.40 as determined according to NFRC 200.
3. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than 35 as determined according to NFRC 500.

I. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

J. Structural-Sealant Joints:

1. Designed to carry gravity loads of glazing.
2. Designed to produce tensile or shear stress of less than 20 psi (138 kPa).

K. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed curtain walls without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. EFCO Corporation
   2. Kawneer North America; an Alcoa company
   3. Oldcastle, Inc
   4. YKK AP America Inc

2.3 FRAMING

A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
   1. Glazing System: Retained mechanically with gaskets on two sides and structural sealant on two sides.
   3. Fabrication Method: Either factory- or field-fabricated system

B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

C. Materials:
   1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
      c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
      d. Structural Profiles: ASTM B 308/B 308M.
   2. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.
      a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
      b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
      c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.
2.4 GLAZING

A. Glazing: Comply with Section 088000 "Glazing."

B. Structural Glazing Sealants: ASTM C 1184, chemically curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in curtain-wall assembly indicated.

1. Color: As selected by Architect from manufacturer's full range of colors

C. Weatherseal Sealants: ASTM C 920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed curtain-wall manufacturers for this use.


D. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

E. Glazing Sealants: As recommended by manufacturer.

1. Sealant shall have a VOC content of 250 g/L or less.
2. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.5 Sun Louvers

A. Provide manufacturer standard sun louver in size and configuration as noted on drawings. Match curtainwall finish and color.

2.6 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from exterior.
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
7. Components curved to indicated radii.

D. Factory-Assembled Frame Units:
1. Rigidly secure nonmovement joints.
2. Prepare surfaces that are in contact with structural sealant according to sealant manufacturer's written instructions, to ensure compatibility and adhesion.
3. Preparation includes, but is not limited to, cleaning and priming surfaces.
4. Seal joints watertight unless otherwise indicated.
5. Install glazing to comply with requirements in Section 088000 "Glazing."

E. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.7 ALUMINUM FINISHES
A. High-Performance Organic Finish: Three-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
1. Color and Gloss: As selected by Architect from manufacturer's full range

2.8 SOURCE QUALITY CONTROL
A. Structural Sealant: Perform quality-control procedures complying with ASTM C 1401 recommendations including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 - EXECUTION

3.1 INSTALLATION
A. General:
1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
6. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.

7. Seal joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.

2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components plumb and true in alignment with established lines and grades.

D. Install glazing as specified in Section 088000 "Glazing."

E. Install weatherseal sealant according to Section 079200 "Joint Sealants" and according to sealant manufacturer's written instructions, to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

3.2 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Test Area: Perform tests on representative areas of structural-sealant-glazed curtain walls.

C. Field Quality-Control Testing: Perform the following test on representative areas of structural-sealant-glazed curtain walls.

1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.

   a. Perform a minimum of two tests in areas as directed by Architect.

D. Structural-Sealant Adhesion: Test structural sealant according to recommendations in ASTM C 1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.

   1. Test a minimum of two areas on each building facade.
   2. Repair installation areas damaged by testing.

E. Structural-sealant-glazed curtain walls will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 084423
SECTION 08 71 00 – FINISH HARDWARE

PART 1 - GENERAL

1.1 Refer to "General and Special Conditions", and "Instructions to Bidders", Division 01 of Specifications. Requirements of these Sections and the project drawings shall govern work in this section.

1.2 Summary:

A. Section Includes:
   1. Furnish all items of Finish Hardware specified, scheduled, shown or required herein except those items specifically excluded from this section of the specification.

B. Specific Omissions: Hardware for the following is specified or indicated elsewhere, unless specifically listed in the hardware sets:
   1. Cabinet Hardware
   2. Signs
   3. Access doors and panels
   4. Overhead and Coiling doors

1.3 Submittals:

A. Hardware Schedule
   1. Submit number of Hardware Schedules as directed in Division 1.
   2. Follow guidelines established in Door & Hardware Institute Handbook (DHI) Sequence and Format for the Hardware Schedule unless noted otherwise.
   3. Schedule will include the following:
      Door Index including opening numbers and the assigned Finish Hardware set.
      Preface sheet listing category only and manufacturer's names of items being furnished as follows:

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>SPECIFIED</th>
<th>SCHEDULED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hinges</td>
<td>Manufacturer A</td>
<td>Manufacturer B</td>
</tr>
<tr>
<td>Lock sets</td>
<td>Manufacturer X</td>
<td>Manufacturer X</td>
</tr>
<tr>
<td>Kick Plates</td>
<td>Open</td>
<td>Manufacturer Z</td>
</tr>
</tbody>
</table>

Hardware Locations: Refer to Article 3.1.C.2 Locations.
Opening Description: Single or pair, number, room locations, hand, active leaf, degree of swing, size, door material, frame material, and UL listing.
Hardware Description: Quantity, category, product number, fasteners, and finish.
Headings that refer to the specified Hardware Set Numbers.
Scheduling Sequence shown in Hardware Sets.
Product data of each hardware item, and shop drawings where required, for special conditions and specialty hardware.

Electrified Hardware system operation description.

"Vertical" scheduling format only. "Horizontal" schedules will be returned "Not Approved."

Typed Copy.

Double-Spacing.

8-1/2 x 11 inch sheets

U.S. Standard Finish symbols or BHMA Finish symbols.

B. Product Data:

1. Submit, in booklet form Manufacturers Catalog cut sheets of scheduled hardware.
2. Submit product data with hardware schedule.

C. Wiring Diagrams:

1. Submit elevation drawings showing relationship of all electrical and pneumatic hardware components to door and frame. Indicate number and gage of wires required.

Include wiring drawing showing point to point wire hook up for all components.

Include system operations descriptions for each type of opening; describe each possible condition.

D. Key Schedule:

1. Submit detailed schedule indicating clearly how the Owner's final keying instructions have been followed.
2. Submit as a separate schedule.

E. Samples:

1. Prior to submittal of the final hardware schedule and prior to final ordering of finish hardware, submit one sample, if required, of each type of exposed hardware unit, finished as required and tagged with full description for coordination with schedule.
2. Samples will be returned to the supplier. Units, which are acceptable and remain undamaged through submittal, review and field comparison procedures, may, after final check of operation, be used in the work, within limitations of keying coordination requirements.

F. Operations and Maintenance Manuals

1. Provide operations and maintenance manuals for each type of door hardware.

G. Factory Order Acknowledgements

1. Submit to General Contractor, the factory order acknowledgement numbers for the various hardware items to be used on the project. The factory order acknowledgement numbers shall help to facilitate and expedite any service that may be required on a particular hardware item. General Contractor shall keep these order acknowledgement numbers on file.
1.4 Quality Assurance

A. Requirements of Regulatory Agencies:

1. Furnish finish hardware to comply with the requirements of laws, codes, ordinances, and regulations of the governmental authorities having jurisdiction where such requirements exceed the requirements of the Specifications.
2. Furnish finish hardware to comply with the requirements of the regulations for public building accommodations for physically handicapped persons of the governmental authority having jurisdiction and to comply with Americans with Disabilities Act.
3. Provide hardware for fire rated openings in compliance with NFPA 80 and state and local building code requirements. Provide only hardware that has been tested and listed by UL for types and sizes of doors required and complies with requirements of door and door frame labels.

B. Supplier:

1. Mechanical Hardware
   Shall be an established firm dealing in contract builders’ hardware. He must have adequate inventory, qualified personnel on staff and be located within 100 miles of the project. The distributor must be a factory-authorized dealer for all materials required. The supplier shall be or have in employment an Architectural Hardware Consultant (AHC).

2. Electrified Hardware:
   Shall be an experienced door hardware supplier who has completed projects with electrified door hardware similar in material, design, and extent to that indicated for this project, whose work has resulted in construction with a record of successful in-service performance, and who is acceptable to manufacturer of primary materials.
   Shall prepare data for electrified door hardware, including shop drawings, based on testing and engineering analysis of manufacturer’s standard units in assemblies similar to those indicated for this project.
   Shall have experience in providing consulting services for electrified door hardware installations.

C. Installer:

1. The Installers shall have a minimum of 3 years experience installing door hardware for project similar in size and complexity.

D. Pre-installation Meeting:

1. Before hardware installation, General Contractor will request a hardware installation meeting be conducted on the installation of hardware; specifically that of locksets, closers, exit devices, overhead stops and coordinators. Manufacturer's representatives of the above products, in conjunction with the hardware supplier for the project, shall conduct the meeting. Meeting to be held at job site and attended by installers of hardware for aluminum, hollow metal and wood doors. Meeting to address proper coordination and installation of hardware, per finish hardware schedule for this specific project, by using installation manuals, hardware schedule, templates, physical product samples and installation videos.
2. When any electrical or pneumatic hardware is specified this meeting shall also include the following trades/installers: Electrical, Security, Alarm systems and Architect.

E. Manufacturer:

1. Obtain each type of hardware (latch and locksets, hinges, closers, etc.) from a single manufacturer, although several may be indicated as offering products complying with requirements.
2. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated.

F. Fire-Rated Door Assemblies:

1. Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.
2. Positive Pressure Test: After 5 minutes into the test, the neutral pressure level in furnace shall be established at 40 inches (1000 mm) or less above the sill.

1.5 Product Delivery, Storage, and Handling:

A. Inventory door hardware on receipt.
B. Label each item of hardware with the appropriate door number and Hardware Schedule heading number, and deliver to the installer so designated by the contractor.
C. Provide secure lock-up for door hardware delivered to Project site.

1.6 Warranties:

A. Refer to Division 1 for warranty requirements.
B. During the warranty period, replace defective work, including labor, materials and other costs incidental to the work. Replace work found to be defective as defined in the General Conditions.

1.7 Maintenance and Service:

A. Furnish a complete set of specialized tools for the Owner’s continued adjustment, maintenance, and removal/replacement of door hardware.

PART 2 - PRODUCT

2.1 Manufacturers:
A. Provide the products of manufacturer designated or if more than one manufacturer is listed, the comparable product of one of the other manufacturers listed. Where only one manufacturer or product is listed, it is understood that this is the owner’s Building Standard and "no substitution" is allowed.

B. The first manufacture listed for each product is the manufacture used in the hardware sets.

2.2 Materials:

A. Screws and Fasteners:

1. Furnish fasteners of the proper type, size, quantity and finish. Use machine screws and expansion shields for attaching hardware to concrete or masonry, and wall grip inserts at hollow wall construction. Furnish machine screws for attachment to reinforced hollow metal doors and frames and reinforced aluminum doors and frames. Furnish full thread wood screws for attachment to solid wood doors and frames. "TEK" type screws are not acceptable.

2. Sex bolts will not be permitted on reinforced metal doors or wood doors where blocking is specified.

B. Hinges:

1. Quantity: Provide the following, unless otherwise indicated:
   - Two Hinges: For doors with heights up to 60 inches (1524 mm).
   - Three Hinges: For doors with heights 61 to 90 inches (1549 to 2286 mm).
   - Four Hinges: For doors with heights 91 to 120 inches (2311 to 3048 mm).
   - For doors with heights more than 120 inches (3048 mm), provide 4 hinges, plus 1 hinge for every 30 inches (750 mm) of door height greater than 120 inches (3048 mm).

2. Hinge Sizes: Provide the following, unless otherwise indicated:
   - 4-1/2 inches high: For all doors with widths of 36 inches or less.
   - 5 inches high: For all doors with widths greater than 36 inches.

3. Hinge Base Metal Thickness: Provide the following, unless otherwise indicated:
   - Medium Weight Doors with Medium Frequency: 0.134 inches thick.
   - Heavy Weight Doors with High Frequency: 0.180 inches thick.

4. Hinge Base Metal: Unless otherwise indicated, provide the following:
   - Exterior Hinges: Stainless steel, with stainless-steel pin.
   - Interior Hinges: Steel, with steel pin.
   - Hinges for Fire-Rated Assemblies: Steel, with steel pin.

5. Hinge Options: Where indicated in door hardware sets or on Drawings:
   - Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for out-swinging exterior doors and out-swinging corridor doors with locks.
   - Corners: Square.
   - Width of Hinges: Shall be sufficient to clear all trim.

6. Fasteners: Provide Phillips flat-head screws comply with the following:
   - Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
   - Wood Screws: For wood doors and frames.
   - Threaded-to-the-Head Wood Screws: For fire-rated wood doors.

Finish screw heads to match surface of hinges.
7. Manufacturers:
   Ives; an Ingersoll-Rand Company (IVE).
   Stanley, a Stanley Black and Decker Company (STA).
   Hager Companies (HAG).
   McKinney; an ASSA Abloy Company (MCK).

C. Continuous Gear Hinge:

1. General: 6063-T6 aluminum alloy, anodized finish (cap on entire hinge painted if specified). Manufacture to template, uncut hinges non-handed, pinless assembly, three interlocking extrusions, full height of door and frame, lubricated polyacetal thrust bearing, fasteners 410 stainless steel plated and hardened. All hinge profiles to be manufactured to template bearing locations, with standard duty bearing configurations at 5-1/8” spacing with a minimum of 16 bearings; and heavy duty at 2-9/16” spacing with a minimum of 32 bearings. Anodizing of material shall be done after fabrication of components so that all bearing slots are anodized.

2. Length: 1” less than door opening height. Fastener 12-24 x 1/2” #3 Phillips keen form stainless steel self-tapping at aluminum and hollow metal doors, 12-1/2” #3 Philips, flathead full thread at wood doors.

3. Furnish fire rated hinges "FR" at labeled openings.

4. Manufacturers:
   For Aluminum frames;
   1) Manufacturers:
      a) Ives; an Ingersoll Rand Company, 112HD series (IVE).
      b) Select Products Ltd., SL11HD series (SEL).
      c) Pemko, FMSLFHD series (PEM).

D. Locks and Latches

1. Bored Locks, Standard Duty:
   All Bored Locks shall be designed to meet BHMA A156.2, Grade 2 test standards and certified by an independent testing laboratory. Locks shall be capable of accepting interchangeable core as specified. Provide 2-3/4 inch backset.
   Provide strikes with extended lips where required to protect trim from being marred by latch bolt. Provide strike lips that do not project more than 1/8" beyond doorframe trim at single doors and have 7/8" lip to center at pairs of 1-3/4" doors.
   Manufacturers:
   1) Falcon; an Ingersoll Rand Company, B series (FAL).
   2) Best; a Stanley Black and Decker Company, 7KC series (BES).
   3) Sargent; an ASSA Abloy Company, 7 Line series (SAR).

   Lockset Trim:
   4) Falcon, Dane
   5) Best, 15C
   6) Sargent, LL

E. Exit Devices:
1. Touchpad Style:
All exit devices shall meet ANSI A156.3, 1994, Grade 1 test standards.
Devices shall be push through type with stainless steel touch pad design.
Center Case: Shall be interchangeable with all functions.
Mechanism End Cap: Shall be a stamped or forged metal. Plastic end caps will not be acceptable.
Trim: Shall be heavy-duty type.
Manufacturers:
1) Falcon; an Ingersoll Rand Company, 25 series (FAL).
2) Sargent; an ASSA Abloy Company, 80 series (SAR).
3) Precision; a Stanley Black and Decker Company, Apex series (PRE).

Trim:
4) As specified in sets.
5) Levers to match lockset design where specified.

F. Surface Door Closers:

1. All Surface Door Closers shall be designed to meet BHMA A156.4, Grade 1 test standards and certified by an independent testing laboratory.
2. Refer to door and frame details and furnish accessories such as drop plates, panel adapters, spacers and supports as required to correctly install door closers. State degree of door swing in the hardware schedule.
3. Provide type of arm required for closer to be located on non-public side of door, unless otherwise indicated.
4. Manufacturers:
   Falcon; an Ingersoll Rand Company, SC70 series (FAL).
   Stanley; a Stanley Black and Decker Company, D-4551 series (RYO).
   Sargent; an ASSA Abloy Company, 350 series (SAR).

G. Door Trim:

1. Push Plates: 6 x 16 x .050 inches. If stile widths will not accept 6”, provide stile width less 1/2”. Provide cut out for thumb turn or cylinder as required.
2. Push-Pull Units: One inch round rod. Push: Straight push bar, Pull: 90 degree off-set, 10” centers. Attach top post of pull back to back with latch stile end of push bar, bottom post of pull and hinge stile end of push bar with end caps.
3. Pulls: One inch round rod, straight 10” centers.
4. Pull Plates: 4 x 16 x .050 inches. 10” center. Provide cut out for thumb turn or cylinder as required.
5. Manufacturers:
   Ives; an Ingersoll Rand Company, series as listed in sets (IVE).
   Equal products from any member of B.H.M.A.

H. Protection Plates:

1. Kick Plates:
   Furnish beveled on 4 edges, countersink fastening, .050” thick x 10" high x 1-1/2" less door width for the push side on single doors and 1” less door width for the pull side on single doors and push or pull side on pairs.
2. Armor Plates:
Furnish beveled on 4 edges, countersink fastening, .050” thick x 42" high x 1-1/2" less door width for the push side on single doors and 1” less door width for the pull side on single doors and push or pull side on pairs.

3. Mop Plates:
Furnish beveled on 4 edges, countersink fastening, .050” thick x 4" high x 1-1/2” less door width for the push side on single doors and 1” less door width for the pull side on single doors and push or pull side on pairs.

4. Manufacturers:
Ives; an Ingersoll Rand Company, 8400 series and 8402 series for rated openings for plates over 16” high (IVE).
Equal products of any B.H.M.A. manufacturer.

I. Door Stops:

1. Wall Bumpers:
Wrought, forged, or cast, approximately 2-1/2 inch diameter, convex or concave rubber center, concealed fasteners.
   1) Ives; an Ingersoll Rand Company, WS407CCV/CVX (IVE).
   2) Equal products of any B.H.M.A. manufacturer.

2. Overhead Stops and Holders:
Size per manufacturer's selector chart. Plastic end caps, hold open mechanisms and shock blocks are not allowed. End caps must be finished same as balance of unit.
Manufacturers:
   1) Glynn-Johnson; an Ingersoll Rand Company, series as listed in sets (GLY).
   2) Equal products of any BHMA manufacturer.

J. Thresholds and Gasketing:

1. Thresholds:
   1/2" high - 5" wide. Cope at jambs.
Furnish full wall opening width when frames are recessed.
Cope in front of mullions if thresholds project beyond door faces.
Furnish with non-ferrous Stainless Steel Screws and Lead Anchors.
   1) National Guard Products Inc. as listed in sets (NGP).
   2) Equal of Zero or Reese

2. Door Sweeps:
Surface Sweeps with drip cap:
   1) National Guard Products Inc., (NGP).
   2) Equal by Zero or Reese

3. Perimeter Gasketing:
Apply to head and jamb stops.
Solid Bar stock all sides
   1) National Guard Products Inc., (NGP).
   2) Equal by Zero or Reese
K. Miscellaneous Hardware:

1. Silencers:
   Provide silencers for all interior doors without gasketing.
   1) Ives; an Ingersoll Rand Company, SR series (IVE).
   2) Equal product of any BHMA manufacturer

2. Drip Caps
   Size drip cap: Door width plus 4”
   1) National Guard Products Inc., 16A (NGP).
   2) Equal by Zero by Reese

L. Furnish items not categorized in the above descriptions but specified by manufacturer’s names in Hardware Sets.

2.3 Finishes:

A. Generally, Dull Chrome, US26D / BHMA 626. Provide finish for each item as indicated in sets.

2.4 Cylinders and Keying:

A. All cylinders for this project will be supplied by one supplier regardless of door type and location. BEST Small Format Interchangeable SFIC is required.

B. The Finish Hardware supplier will meet with Architect and/or Owner to finalize keying requirements and obtain keying instructions in writing.

C. Provide a cylinder for all hardware components capable of being locked.

D. Provide cylinders master and grand master keyed to a new 6 pin system according to Owner's instructions. Provide two change keys for each cylinder, master and grand master keys as required by Owner.

E. Manufacturers:
   1. Falcon; an Ingersoll Rand Company, (FAL).
   2. Best; a Stanley Black and Decker Company, (BES).

2.5 Templates and Hardware Location:

A. Furnish hardware made to template. Supply required templates and hardware locations to the door and frame manufacturers.

B. Furnish metal template to frame/door supplier for continuous hinge.

PART 3 - EXECUTION
3.1 Installation

A. General:

1. Install hardware according to manufacturer’s installations and template dimensions. Attach all items of finish hardware to doors, frames, walls, etc. with fasteners furnished and required by the manufacture of the item.
2. Provide blocking/reinforcement for all wall mounted Hardware.
3. Reinforced hollow metal doors and frames and reinforced aluminum door and frames will be drilled and tapped for machine screws.
5. Continuous gear hinges attached to hollow metal doors and frames and aluminum doors and frames: 12-24 x 1/2" #3 Phillips Keenform self-tapping. Use #13 or 3/16 drill for pilot.
6. Continuous Gear Hinges require continuous mortar guards of foam or cardboard 1/2" thick x frame height, applied with construction adhesive.
7. Install weather-strip gasket prior to parallel arm closer bracket, rim exit device or any stop mounted hardware. Gasket to provide a continuous seal around perimeter of door opening. Allow for gasket when installing finish hardware. Door closers will require special templating. Exit devices will require adjustment in backset.

B. Installation of Access Control Components:

1. Electrical Contractor Provide all pathways (boxes and conduit) into doors and at wall mounted device locations (readers, wall actuators, REX motion detectors, etc.). Provide 120V power and connection to Automatic door power operators. Install and wire low voltage cabling for door operator wall actuator stations. Provide fire alarm circuit to future security access system for door lock interface.

2. General Trades/Access Control Supplier/Contractor: Provide all electrified door hardware. Hardware to be provided with quick-connect plugs between components (e.g. electrified panic plugs into power transfer) and pig tail connections at final device in the chain. Provide DPDT door position switches for all exterior doors and all card reader doors including wiring pigtails from switch. Provide Request To Exit switches in all electrified door hardware for alarm shunt. Provide wiring diagrams and power requirements for all hardware to be turned over to future security contractor.

3. Security Contractor: Provide door hardware low voltage operating power from centralized power supplies. Provide all low voltage wiring connections at each door to the wiring pigtails provided by the general trades contractor. Provide all low voltage signal and power wiring to each controlled door from the door access system to be located in the Data Center. Provide low voltage wiring interface to all operators on access doors to interlock operator with door lock.

C. Locations:

1. Dimensions are from finish floor to center line of items.
2. Include this list in Hardware Schedule.
D. Final Adjustment:

1. The general contractor shall provide the services of a representative to inspect material furnished and its installation and adjustment, and to instruct the Owner's personnel in adjustment, care and maintenance of hardware.

2. Locksets, closers and exit devices shall be inspected by the factory representative to insure correct installation and proper adjustment in operation. The manufacturer's representative shall prepare a written report stating compliance, and also recording locations and kinds of non-compliance. The original report shall be forwarded to the Architect with copies to the Contractor, hardware supplier, hardware installer and building owner.

E. Technical and Warranty Information:

1. At the completion of the project, the technical and warranty information coalesced and kept on file by the General Contractor shall be given to the Owner or Owner’s Agent. In addition to both the technical and warranty information, all factory order acknowledgement numbers supplied to the General Contractor during the construction period shall be given to the Owner or Owner’s Agent. The warranty information and factory order acknowledgement numbers shall serve to both expedite and properly execute any warranty work that may be required on the various hardware items supplied on the project.

Hardware Sets for SE-DML:

2. 1. HARDWARE SET 1 – Mechanical/Storage Rooms, Single Leaf
   a. 3 ea. Hinges
   b. 1 ea. Cylindrical Lockset, Storeroom Function
   c. 1 ea. Core
   d. 1 ea. Cylinder and Trim
   e. 1 ea. Concealed Overhead Stop
   f. 1 set Frame Silencers
   g. 1 ea. Kickplate
   h. 1 ea. Closer

2. HARDWARE SET 2 – Group Restrooms, Single Leaf
   a. 3 ea. Hinges
   b. 1 ea. Pushplate
   c. 1 ea. Pull plate
   d. 1 ea. Closer
   e. 1 set Frame Silencers
   f. 1 ea. Kickplate
3. HARDWARE SET 3 – Aluminum Doors, Double Leaf - Access Control.
   a. 5 ea. Hinges – by Aluminum Entrance
   b. 1 ea. Electrified Hinge
   c. 1 ea. Removable Mullion – by Aluminum Entrance
   d. 1 ea. Exterior Pull – by Aluminum Entrance
   e. 1 ea. Rim Exit Device – Electrified
   f. 1 ea. Rim Exit Device
   g. 2 ea. Core
   h. 2 ea. Cylinder and Trim
   i. 2 ea. Closer with Stop
   j. 1 ea. Power Supply (24V)

4. HARDWARE SET 4 – Single Door Access Control-Entrance
   a. 3 ea. Hinges
   b. 1 ea. Rim Exit Device (electrified)
   c. 1 ea. Power Transfer
   d. 1 ea. Door Position Switch
   e. 1 ea. Core
   f. 1 ea. Cylinder and Trim
   g. 1 set Frame Silencers
   h. 1 ea. Threshold
   i. 1 ea. Kickplate
   j. m. 1 ea. Power Supply (24V)

5. HARDWARE SET 5 – Single Exterior Door
   a. 1 ea. Core
   b. 1 ea. Cylinder
   c. 3 ea. Hinges
   d. 1 ea. Rim Exit Device with exterior trim
   e. 1 ea. Drip Cap – full length
   f. 1 ea. Weatherstripping
   g. 1 ea. Threshold
   h. 1 ea. Door viewer

6. HARDWARE SET 6 – Exterior, Single Leaf – Access Control
   a. 1 ea. Continuous Hinges – by Aluminum Entrance
   b. 1 ea. Exterior Pull – by Aluminum Entrance
   c. 1 ea. Drip Cap – full length – by Aluminum Entrance
   d. 1 ea. Weatherstripping – by Aluminum Entrance
   e. 1 ea. Threshold – by Aluminum Entrance
   f. 1 ea. Rim Exit Device
   g. 1 ea. Electric Strike
   h. 1 ea. Power Transfer
   i. 2 ea. Core
   j. 2 ea. Cylinder and Trim
   k. 2 ea. Closer with Stop
   l. 1 ea. Power Supply (24V)
7. HARDWARE SET 7 – Office, Single Leaf
   a. 3 ea. Hinges
   b. 1 ea. Cylindrical Lockset, Office Function
   c. 1 ea. Core
   d. 1 ea. Cylinder and Trim
   e. 1 ea. Concealed Overhead Stop
   f. 1 set Frame Silencers
   g. 1 ea. Kickplate

8. HARDWARE SET 8 – Mechanical/Storage Rooms, Double
   a. 6 ea. Hinges
   b. 1 ea. Cylindrical Lockset, Storeroom Function
   c. 1 ea. Core
   d. 1 ea. Cylinder and Trim
   e. 1 ea. Manual Flush Bolts
   f. 1 ea. Concealed Overhead Stop
   g. 1 set Frame Silencers
   h. 1 ea. Kickplate

9. HARDWARE SET 9 – Single door – Access control
   a. 3 ea. Hinges
   b. 1 ea. Cylindrical Lockset, Storeroom Function
   c. 1 ea. Core
   d. 1 ea. Cylinder and Trim
   e. 1 ea. Closer with Stop
   f. 1 set Seals
   g. 1 ea. Kickplate

10. HARDWARE SET 10 – Aluminum Entrance Doors, Single Leaf - Access Control
    a. 1 ea. Continuous Hinges – by Aluminum Entrance
    b. 1 ea. Exterior Pull – by Aluminum Entrance
    c. 1 ea. Drip Cap – full length – by Aluminum Entrance
    d. 1 ea. Weatherstripping – by Aluminum Entrance
    e. 1 ea. Threshold – by Aluminum Entrance
    f. 1 ea. Rim Exit Device
    g. 1 ea. Electric Strike
    h. 1 ea. Power Transfer
    i. 2 ea. Core
    j. 2 ea. Cylinder and Trim
    k. 2 ea. Closer with Stop
    l. 1 ea. Power Supply (24V)

11. HARDWARE SET 11 – Single Door Aluminum Passage
    a. 3 ea. Hinges – by Aluminum Entrance
    b. 1 ea. Pull – by Aluminum Entrance
    c. 1 ea. Push – by Aluminum Entrance
    d. 1 ea. Closer with Stop and hold open function
12. HARDWARE SET 12 – Storage, Single Leaf
   a. 3 ea. Hinges
   b. 1 ea. Cylindrical Lockset, Classroom Function (keyed)
   c. 1 ea. Core
   d. 1 ea. Cylinder and Trim
   e. 1 ea. Concealed Overhead Stop
   f. 1 set Frame Silencers
   g. 1 ea. Kickplate

13. HARDWARE SET 13 – Private Restroom
   a. 3 ea. Hinges
   b. 1 ea. Cyld Lockset, Privacy Function w/ Occupied Notation
   c. 1 ea. Core
   d. 1 ea. Cylinder and Trim
   e. 1 ea. Concealed Overhead Stop
   f. 1 set Frame Silencers
   g. 1 ea. Kickplate

14. HARDWARE SET 14 – Sliding Entrance Doors
   a. 1 ea. Core
   b. electrified lockset – by sliding door manufacturer
   c. Balance of hardware by sliding door manufacturer

15. HARDWARE SET 15 – Sliding Entrance Doors- Exterior Door
   a. 1 ea. Core
   b. Balance of hardware by sliding door manufacturer

16. HARDWARE SET 16 – Single Door Passage

17. HARDWARE SET 17 – Double Door Aluminum Passage
   a. 6 ea. Hinges – by Aluminum Entrance
   b. 2 ea. Pull – by Aluminum Entrance
   c. 2 ea. Push – by Aluminum Entrance
   d. 2 ea. Closer with Stop and hold open function

18. HARDWARE SET 18 – Single Door Access Control Interior
   a. 2 ea. Hinges
   b. 1 ea. Electrifed Hinge
   c. 1 ea. Cyld Lockset, Storeroom Function
   d. 2 ea. Core
   e. 2 ea. Cylinder and Trim
   f. 2 ea. Closer with Stop
   g. 1 ea. Power Supply (24V)

19. HARDWARE SET 19 – Single Door Access Control Interior
   a. 3 ea. Hinges – by Aluminum Entrance
   b. 1 ea. Pull – by Aluminum Entrance
   c. 1 ea. Push – by Aluminum Entrance
   d. 1 ea. Closer with Stop and hold open function
   e. 1 ea. Cylinder and Trim
SECTION 08 80 00 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All provisions of the Contract Documents apply to this Section. The Contractor for this Section shall be responsible for complete familiarity with same.

1.2 SUMMARY

A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
   1. Doors.
   2. Glazed aluminum entrances and storefronts.
   3. Interior borrowed lites.

B. Related Sections:
   1. Section 018113 – Sustainability Requirements

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design glass, including comprehensive engineering analysis according to ASTM E 1300 by a qualified professional engineer, using the following design criteria:
   1. Vertical Glazing: For glass surfaces sloped 15 degrees or less from vertical, design glass to resist design wind pressure based on glass type factors for short-duration load.
   2. Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass to resist each of the following combinations of loads:
      a. Outward design wind pressure minus the weight of the glass. Base design on glass type factors for short-duration load.
      b. Inward design wind pressure plus the weight of the glass plus half of the design snow load. Base design on glass type factors for short-duration load.
      c. Half of the inward design wind pressure plus the weight of the glass plus the design snow load. Base design on glass type factors for long-duration load.
   3. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

1.4 SUBMITTALS

A. Provide manufacturers literature and data for item to be utilized, including glass, glazing materials, and accessories.

B. LEED Submittals:
1. Product Data for Credit EQ 4.1: For glazing sealants used inside of the weatherproofing system, including printed statement of VOC content.

C. Glass Samples: For each type of glass product glass; 12 inches (300 mm) square.

D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

E. Preconstruction adhesion and compatibility test report.

1.5 QUALITY ASSURANCE

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.


B. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction or the manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Provide labels showing glass manufacture’s identity, type of glass, thickness, and quality. Labels shall remain on glass until it has been set and approved by the Architect.

D. Thermal Performance Properties

1. Solar Heat Gain Coefficient: NFRC 200; \( <=0.40. \)

E. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F (250 deg C), and the fire-resistance rating in minutes.

F. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

G. Applicable Standards:
1. ANSI Standards:
4. ASTM Standards:
9. FGMA “Glazing Manual” for applicable recommendations of Flat Glass Marketing Association

1.6 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
   1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form in which laminated-glass manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
   1. Warranty Period: 10 years from date of Substantial Completion.

C. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
   1. Warranty Period: 10 years from date of Substantial Completion.

D. Manufacturer’s Special Warranty for Weather Tightness: Manufacturer’s standard form in which the manufacturer agrees to replace, or correct, window glazing units that are no longer weather tight; this shall include, but not be limited to, air infiltration and water leaks. The warranty periods listed below shall be from the date of Substantial Completion.
   1.
2. Coated Glass: Two (2) years.
3. Laminated Glass: Five (5) years.
4. Insulated Glass: Ten (10) years.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS, GENERAL

A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.

B. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.

C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
   1. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
   2. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
   3. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.2 GLASS PRODUCTS

A. Glass Types:
   1. Float Glass, ASTM C1036, Type I, Quality q.3
   2. Wire Glass: Type II. Locations as noted on drawings
   3. Heat Treated Glass Products: Tempered Glass ASTM C1048 to be used in the following:
      Human Impact Hazard Condition: Glazing conditions in which glass break age might readily occur through human activity. Such glazing locations shall be glazed with glass designation in this section for such use. The following location requires glazing with glass designation for human impact hazard condition; for multiple glazed lites, except as otherwise indicated, human impact hazard condition is limited to side of lite meeting the following conditions:
        1) Glazed lites in doors.
2) Glazed lites with an exposed edge within 24 inches of a vertical edge of a door in closed position and the bottom exposed edge of the lite is less than 60 inches above the walking surface.

3) Glazed lites when all of the following apply:
   a. Exposed area of the lite is greater than 9 square feet.
   b. Exposed bottom of area lite is less than 18 inches above the floor.
   c. Exposed top edge of lite is greater than 36 inches above the floor.
   d. A walking surface is within 36 inches horizontally from the lite.
   e. Exposed lite is not protected on walking surface side(s) with a horizontal protective bar located 34 to 38 inches above floor which has vertical dimension of 1 1/2 inches and will not deflect into contact with light under a horizontal load of 50 pounds per square foot.

4) Exposed glazing installed as part of a railing/guard assembly.

5) Additional locations as required by the Ohio Building Code, Latest Edition.

6) Laminated Glass Units: Polyvinyl butyral inner layer.

7) Sealed Insulating Glass Units: ASTM E 774, Class A
   a. Provide low-emissivity insulating glass units.
   b. Coated interior face of panel.


B. Glass Usage:

1. Exterior:
   a. Glass for Exterior Doors:
      1) ¼ inch thick, tempered glass to match exterior windows units.
         a. Exterior Sidelights and Transoms: Outer light to be ¼” Solarban 60 low “e” glass, inner light to be ¼” clear float glass. Provide tempered glass at locations as required per OBC and/or human hazard locations. Tint as selected by Architect from full range of standard colors and light transmissions.
         b. Glass for Exterior Storefront and other insulated applications:
1) Insulated unit: Outer light to be ¼” Solarban 60 low “e” glass, inner light to be ¼” tinted float glass to match existing building glazing. Provide tempered glass at locations as required per OBC and/or human hazard locations. Tint as selected by Architect from full range of standard colors and light transmissions.

2. Interior:
   b. Glass for Interior Fire Rated Doors and Windows: ¼ inch clear wire glass, polished both sides.

C. Glazing Sealants

1. General
   a. Provide materials as recommended by the manufacturer for the required application and condition of installation in each case. Provide only compounds which are proven to be fully compatible with surfaces contacted.

2. Silicone Rubber Glazing Sealant: Shall be silicone rubber, one part elastomeric sealant complying with FS TT-S-001543, Class A. Provide acid type for nonporous channel surfaces and provide nonacid medium-modulus type for porous channel surfaces.

3. Preformed Butyl Rubber Glazing Sealant: Shall be tape or ribbon (coiled on release paper) of polymerized butyl or mixture of butyl and polyisobutylene, compounded with inert fillers and pigments, solvent-based with minimum of 95 percent solids with thread or fabric reinforcement, tack-free within 24 hours, paintable, nonstaining.
   a. Provide combination tape and encased continuous rubber shim of approximately 50 durometer hardness.

4. Two Component Polysulfide Glazing Sealant: Shall be polysulfide 2 part elastomeric sealant, complying with FS TT-S-00227, Class A, Type 2 (nonsag) with container bearing Thiokol Chemical Corp. seal of approval. Material shall be compounded by manufacturer specifically for glazing.

D. Glazing Gaskets

1. Polyvinyl Chloride Glazing Gaskets: Shall be extruded, flexible PVC gaskets of the profile and hardness shown or as required for watertight construction, complying with ASTM D2287.

2. Structural Rubber Glazing Gaskets: Shall be neoprene extrusions with injection molded corner units, fabricated into frames with either integral or separate locking strips (zippers), complying with ASTM C542, black.

E. Miscellaneous Glazing Materials
1. Setting Blocks: Shall be neoprene, 70-90 durometer hardness with proven compatibility with sealants used.

2. Spacers: Shall be neoprene, 40-50 durometer hardness with proven compatibility with sealants used.

3. Compressible Filler Rod: Shall be closed-cell or waterproof jacketed rodstock of synthetic rubber or plastic foam with proven compatibility with sealants used. Rod shall be flexible and resilient with 5-10 PSI compression strength for 25 percent deflection.

4. Cleaners, Primers and Sealers: Shall be products as recommended by sealant or gasket manufacturer.

   F. Each light of tempered, laminated, glass shall bear permanent identification by the manufacturer, indicating type, thickness and manufacturer's name.

   G. Exterior and vestibule glass units shall withstand 15 PSF windload.

   H. Provide for expansion control in accordance with manufacturer's recommendations.

PART 3 - EXECUTION

3.1 GLAZING, GENERAL

   A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

   B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

   C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

   D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

   E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

   F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

   G. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).
H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

3.2 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Apply heel bead of elastomeric sealant, where required by the glazing manufacturer, for the application.

F. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

G. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.3 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.
3.4 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.5 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

E. Responsibility for glass breakage shall be assumed by this Contractor until glass is properly set by him, and he shall replace all broken glass caused by binding or faulty setting.

END OF SECTION 08 80 00
SECTION 08 91 19 - LOUVERS AND VENTS

PART 1 - GENERAL

2. SCOPE OF WORK
   A. Furnish all labor, materials, services and equipment required for the complete installation of louvers and vents, complete with all accessory items, as specified herein and as shown on the Drawings.
   B. Related Sections:
      1. Section 018113 – Sustainability requirements

3. QUALITY ASSURANCE
   A. Performance Requirements: Where louvers are indicated to comply with specific performance requirements, provide units whose performance ratings have been determined in compliance with AMCA Standard 500.
   C. Field Measurements: Verify size, location and placement of louver units prior to fabrication, wherever possible.
   D. Shop Assembly: Coordinate field measurements and shop drawings with fabrication and shop assembly to minimize field adjustments, splicing, mechanical joints and field assembly of units. Pre-assembled units in shop to greatest extents possible and disassemble only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinate installation.
   E. Manufacturers:
      1. Greenheck, Schoefield WI
      2. Airolite Company, Schoefield WI
      3. American Warming & Ventilating, Holland, OH 43528
      4. Arrow United Industries Inc., Wyalusing, PA 18853
      5. C/S Louver Systems, Cranford, NJ 07016
      6. Ruskin, Grandview, MO 64030

4. PERFORMANCE REQUIREMENTS
   A. Louvers shall meet the following performance requirements:
1. Wind Load – 20 PSF uniform pressure acting inwards and outwards.

2. Louver Free Area (based on 48” x 48”) – 7.0 SF minimum.

3. Static Pressure Loss – not to exceed 0.10” W.G. intake at 800-fpm free area intake velocity, .05” W.G. exhaust.

4. Water Penetration – not less than 95% effectiveness when subjected to a rainfall rate of 3 inches per hour and a wind speed of 29 mph.

4. SUBMITTALS

A. Product Data: Submit manufacturer's specifications; certified test data, where applicable; and installation instructions for required products, including finishes.

B. Shop Drawings: Submit shop drawings for fabrication and erection of lower units and accessories. Include plans, elevations and details of sections and connections to adjoining work. Indicate materials, finishes, fasteners, joinery and other information to determine compliance with specified requirements.

PART 2 - PRODUCTS

1. MATERIALS

A. Aluminum Extrusions: ASTM B221, Alloy 6063-T52.

B. Fastenings: Use same material as items fastened, unless otherwise indicated. Fasteners for exterior applications may be hot-dip galvanized, stainless steel or aluminum. Provide types, gauges and lengths to suit unit installation conditions. Use Phillips flat-head machine screws for exposed fasteners, unless otherwise indicated.

C. Anchors and Inserts: Use non-ferrous metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use steel or lead expansion bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

D. Bituminous Paint: SSPC-Paint 12 (cold-applied asphalt mastic).

E. Provide ½” mesh, 063” aluminum bird screen in removable extruded aluminum frames.

2. FABRICATION, GENERAL

A. Provide louvers and accessories of design, materials, sizes, depth, arrangement, and metal thicknesses as shown on drawings, or if not shown, as required for optimum performance with respect to air flow; water penetration; air leakage, where applicable (for adjustable units, if any); strength; durability; and uniform appearance, as suited to applications shown and intended use.
B. Fabricate frames including integral sills to suit adjacent construction with adequate tolerances for installation including application of sealants in joints between louvers and adjoining work, where applicable.

C. Include supports, anchorages, and accessories required to achieve a complete assembly, properly installed.

D. Provide concealed vertical mullions of type and at spacings indicated but not further apart than recommended by manufacturer, or 72", whichever is less. At horizontal joints between louver units, provide horizontal mullions except where continuous vertical assemblies are indicated.

E. Join frame members to one another and to stationary louver blades by welding, except where indicated otherwise or where field bolted connections between frame members are made necessary by size of louvers. Maintain equal blade spacing including separation between blades and frames at head and sill to produce a uniform appearance.

3. STATIONARY EXTRUDED ALUMINUM WALL LOUVERS

A. Horizontal Drainable Blade Louvers: Units designed to collect and drain water to exterior at sill by means of gutters in front edges of blades, and channels in jambs and mullions. Furnish units with extrusions not less than 0.081" thick, 6" depth, and sizes indicated, complying with the following performance requirements:

1. Provide free area, static pressure loss, and water penetration limitations as specified in Division 15.

2. Furnish blank-off panels as required to close off unused open areas of louver. Coordinate size with HVAC contractor.

4. METAL FINISHES

A. General: Comply with NAAMM "Metal Finishes Manual" for finish designations and application recommendations, except as otherwise indicated. Apply finishes in factory after products are assembled. Protect finishes on exposed surfaces with protective covering, prior to shipment. Remove all scratches and blemishes from exposed surfaces which will be visible after completing finishing process.

B. Finish:

1. Two coat fluropolymer coating utilizing 70% Kynar 500 resin. Finish shall comply with performance criteria of AAMA 605.2, selected from manufacturers list of standard colors by Architect.
PART 3 - EXECUTION

1. PREPARATION

Coordinate setting drawings, diagrams, templates, instructions and directions for the installation of anchorages which are to be embedded in concrete or masonry construction. Coordinate the delivery of such items to the project site.

2. INSTALLATION

A. Locate and place louver units plumb, level and in proper alignment with adjacent work.

B. Use concealed anchorages wherever possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers, as indicated.

D. Repair finishes damaged by cutting, welding, soldering, and grinding operations required for fitting and jointing. Restore finishes and prime coats of paint so that there is no evidence of corrective work. Return items which cannot be refinshed in the field to the shop, make the required alterations, and refinish the entire unit, or provide new units, at Contractor's option.

E. Protect galvanized and non-ferrous metal surfaces from corrosion or galvanic action by application of a heavy coating of bituminous paint on surfaces which will be in contact with concrete, masonry or dissimilar metals.

F. Refer to Division 7 sections for sealants in connection with installations of louvers.

END OF SECTION 089000
SECTION 09 22 16 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
   2. Suspension systems for interior gypsum ceilings and soffits.

B. Related Sections:
   1. Section 018113 – Sustainability Requirements

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.

   2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regionally manufactured and regionally extracted and manufactured materials. Include statement indicating cost for each regionally manufactured material.
      a. Include statement indicating location of manufacturer and distance to Project for each regionally manufactured material.
      b. Include statement indicating location of manufacturer and point of extraction, harvest, or recovery for each raw material used in regionally extracted and manufactured materials. Indicate distance to Project and fraction by weight of each regionally manufactured material that is regionally extracted.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: Provide materials and construction identical to those tested according to ASTM E 119.

B. STC-Rated Assemblies: Provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413.
2.2 FRAMING SYSTEMS

NOTE – punched or modified stud framing systems (i.e. drywall framing members) will not be accepted – i.e. ProStud or equivalent.

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

B. Steel Studs and Runners: ASTM C 645.
   1. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).
   2. Depth: As indicated on Drawings, 3-5/8 inches (92 mm) or 6 inches (152 mm).

C. Slip-Type Head Joints: Where indicated, provide the following in thickness not less than indicated for studs and in width to accommodate depth of studs:
   1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch- (51-mm-) deep flanges, installed with studs friction fit into top runner and with continuous bridging located within 12 inches (305 mm) of the top of studs to provide lateral bracing.
   2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- (51-mm-) deep flanges and fastened to studs, and outer runner sized to friction fit inside runner.
   3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes due to deflection of structure above.
      a. Products: Subject to compliance with requirements, provide products by one of the following:
         1) Dietrich Metal Framing;
         2) MBA Building Supplies;
         3) Steel Network Inc. (The);
         4) Superior Metal Trim;
         5) Telling Industries;

D. Firestop Tracks: Manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Fire Trak Corp.;
      b. Grace Construction Products;
      c. Metal-Lite, Inc.;

E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
   1. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).
F. Cold-Rolled Channel Bridging: Steel, 0.053-inch (1.34-mm) minimum base-metal thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
   1. Depth: 1-1/2 inches (38 mm).
   2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch- (1.72-mm-) thick, galvanized steel.

   1. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).
   2. Depth: [As indicated on Drawings] [7/8 inch (22.2 mm)] [1-1/2 inches (38.1 mm)].

H. Resilient Furring Channels: 1/2-inch- (13-mm-) deep, steel sheet members designed to reduce sound transmission.
   1. Configuration: Asymmetrical or hat shaped.

I. Cold-Rolled Furring Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
   1. Depth: 3/4 inch (19 mm).
   2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of 0.033 inch (0.8 mm).
   3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

J. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (31.8 mm), wall attachment flange of 7/8 inch (22 mm), minimum uncoated-metal thickness of 0.018 inch (0.45 mm), and depth required to fit insulation thickness indicated.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

B. Hanger Attachments to Concrete:
   1. Anchors: Capable of sustaining a load equal to 5 times that imposed as determined by ASTM E 488.
      a. Type: Postinstalled, expansion anchor.
   2. Powder-Actuated Fasteners: Capable of sustaining, a load equal to 10 times that imposed as determined by ASTM E 1190.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.

D. Flat Hangers: Steel sheet, 1 by 3/16 inch (25 by 5 mm) by length indicated.
E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch (1.34 mm) and minimum 1/2-inch- (13-mm-) wide flanges.

1. Depth: 1-1/2 inches (38 mm).

F. Furring Channels (Furring Members):

1. Cold-Rolled Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges, 3/4 inch (19 mm) deep.
2. Steel Studs and Runners: ASTM C 645.
   a. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).
   b. Depth: [As indicated on Drawings] [3-5/8 inches (92 mm)].
3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch (22 mm) deep.
   a. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).
4. Resilient Furring Channels: 1/2-inch- (13-mm-) deep members designed to reduce sound transmission.
   a. Configuration: Asymmetrical or hat shaped.

2.4 AUXILIARY MATERIALS

A. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.

1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
4. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Install bracing at terminations in assemblies.
D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.2 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.

2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
   a. Install two studs at each jamb unless otherwise indicated.
   b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
   c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
   a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

6. Curved Partitions:
   a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
   b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches (150 mm) o.c.
E. Direct Furring:
   1. Screw to wood framing.
   2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.

F. Z-Furring Members:
   1. Erect insulation vertically and hold in place with Z-furring members spaced 24 inches (610 mm) o.c.
   2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
   3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches (305 mm) from corner and cut insulation to fit.

G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

3.3 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
      a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
   3. Do not attach hangers to steel roof deck.
   4. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
   5. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
   6. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
F. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 09 22 16
SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Interior gypsum board.
   2. Exterior gypsum board for ceilings and soffits.
   3. Tile backing panels.

B. Related Sections
   1. Section 018113 – Sustainability requirements

1.2 SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content.
   2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

C. Low Emitting Materials: For ceiling and wall assemblies, provide materials and construction identical to those tested in assembly and complying with the testing and product requirements of
the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.2 GYPSUM BOARD, GENERAL

A. Regional Materials: Gypsum panel products shall be manufactured within 500 miles (800 km) of Project site.

2.3 INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Gypsum.
2. CertainTeed Corp.
3. Georgia-Pacific Gypsum LLC.
4. Lafarge North America Inc.
6. PABCO Gypsum.
7. Temple-Inland.
8. USG Corporation.

B. Gypsum Board, Type X: ASTM C 1396/C 1396M.

1. Thickness: 5/8 inch (15.9 mm).
2. Long Edges: Tapered and featured (rounded or beveled) for prefilling.

C. Flexible Gypsum Board: ASTM C 1396/C 1396M. Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.

1. Thickness: 1/4 inch (6.4 mm).
2. Long Edges: Tapered.

D. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.

1. Core: 5/8 inch (15.9 mm), Type X.
2. Long Edges: Tapered.

E. Abuse-Resistant Gypsum Board: ASTM: C 1629/C 1629M

1. Core: 5/8 inch (15.9mm), Type X.
2. Long Edges: Tapered.
2.4 EXTERIOR GYPSUM BOARD FOR CEILINGS AND SOFFITS

A. Exterior Gypsum Soffit Board: ASTM C 1396/C 1396M, with manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Gypsum.
   b. CertainTeed Corp.
   c. Georgia-Pacific Gypsum LLC.
   d. Lafarge North America Inc.
   e. National Gypsum Company.
   f. PABCO Gypsum.
   g. Temple-Inland.
   h. USG Corporation.

2. Core: 5/8 inch (15.9 mm), Type X.

2.5 TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or 1325. Formed in a continuous process of aggregated Portland cement slurry with polymer-coated glass-fiber mesh completely encompassing edges and front & back surfaces with manufacturer's standard formed smooth edges.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. C-Cure: C-Cure Board 990.
   c. FinPan, Inc.: Util-A-Crete Concrete Backer Board.
   d. USG Corporation: DUROCK Cement Board.

2. Thickness:
   a. 5/8 inch (15.9 mm), for installation over metal studs, in lieu of 5/8” gypsum board at wall areas scheduled to receive tiling specified in Division 09 Section “Tiling”.
   b. ½” (12.7 mm) for installation over new CMU walls, or all types of existing walls, scheduled to receive tiling specified in Division 09 Section “Tiling”.


2.6 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.

1. Material: Hot-dip galvanized steel sheet, plastic, or rolled zinc.

C. Aluminum Trim: ASTM B 221 (ASTM B 221M), Alloy 6063-T5.

D. Gypsum board aluminum reveals, square.

2.7 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:
   1. Interior Gypsum Board: Paper.
   4. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

2.8 AUXILIARY MATERIALS

A. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
   1. Laminating adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Laminating adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

C. Sound Attenuation Blankets: As specified in Division 07 Section “Thermal Insulation”.

D. Acoustical Joint Sealant: ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings as demonstrated by testing according to ASTM E 90.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Accumetric LLC; BOSS 824 Acoustical Sound Sealant.
      b. Grabber Construction Products; Acoustical Sealant GSC.
      c. Pecora Corporation; AC-20 FTR.
      e. USG Corporation; SHEETROCK Acoustical Sealant.
2. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Acoustical joint sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Thermal Insulation: As specified in Division 07 Section "Thermal Insulation."

F. Vapor Retarder: As specified in Division 07 Section "Thermal Insulation."

PART 3 - EXECUTION

3.1 APPLYING AND FINISHING PANELS

A. Comply with ASTM C 840.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

D. Install trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
   1. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.
   2. Prefill open joints, rounded or beveled edges, and damaged surface areas.
   3. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
   4. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
      1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
      2. Level 2: Panels that are substrate for tile or panels that are substrate for acoustical tile.
      3. Level 3: Not used
      4. Level 4: All gypsum board surfaces that will be exposed to view unless otherwise indicated.
         a. Primer and its application to surfaces are specified in other Division 09 Sections.
      5. Level 5: At locations as noted on drawings.
         a. Primer and its application to surfaces are specified in other Division 09 Sections.
H. Protect adjacent surfaces from drywall compound and texture finishes and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

I. Remove and replace panels that are wet, moisture damaged, and mold damaged.

END OF SECTION 092900
SECTION 093000 – CERAMIC TILE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Floor and Wall tile.

1.3 RELATED SECTIONS

A. Section 07920 - Joint Sealers: Sealing of expansion, contraction, control, and isolation joints in tile surfaces.

B. Section 09250 - Gypsum Board: Water-resistant gypsum backing board installed as part of gypsum wallboard systems.

C. Section 018113 – Sustainability Requirements

1.4 SUBMITTALS

A. Product Data: For each type of product specified.

B. Shop Drawings: Indicate tile patterns and locations and widths of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

C. Samples for Verification:
   1. Full-size units of each type and composition of tile and for each color and finish required.
   2. Grout of each type and for each color required.
   3. Metal edge strips in 6-inch (150-mm) lengths.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement of ANSI A137.1 for labeling sealed tile packages.

B. Prevent damage or contamination to materials by water, freezing, foreign matter, and other causes.

1.6 PROJECT CONDITIONS

A. Maintain environmental conditions and protect work during and after installation to comply with referenced standards and manufacturer's printed recommendations.
B. Vent temporary heaters to exterior to prevent damage to tile work from carbon dioxide buildup.

C. Maintain temperatures at 50 deg F (10 deg C) or more in tiled areas during installation and for 7 days after completion, unless higher temperatures are required by referenced installation standard or manufacturer's instructions.

1.7 EXTRA MATERIALS

A. Deliver extra materials to Owner. Furnish extra materials that match products installed as described below, packaged with protective covering for storage and identified with labels clearly describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.

2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Basis-of-Design Product: The design for the tile is based on the manufacturer identified below. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:


B. Dry-Set Mortars: Subject to compliance with project requirements, manufacturers offering specified items which may be incorporated in the work include, but are not limited to the following:

1. WR Bonsal Company.

2. Bostick Findley, Inc.

3. Laticrete.

C. Non-Sanded Grouts: Subject to compliance with project requirements, manufacturers offering specified items which may be incorporated in the work include, but are not limited to the following:

1. WR Bonsal Company.

2. Bostick Findley, Inc.

3. Laticrete.

2.2 MATERIALS, GENERAL

A. Local/Regional Materials: Give preference to manufacturer’s whose facilities are within a 500 mile radius of the project site. Also give preference to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.
B. VOC Content: Adhesives, sealants, paints, welding, and coatings applied on-site on the interior of the building and products used on the interior of the building shall comply with VOC limits as specified below.
   1. Use materials that have the lowest possible VOC content in units of g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 TILE PRODUCTS


B. Glazed Floor Tile: ASTM C1028, with a wet coefficient of friction of 0.5 or greater. Provide flat tile complying with the following requirements:
   1. Thickness: 5/16-inch Nominal.
   2. Tile Dimensions: 8 inches by 8 inches.
   3. Face: Plain with cushion edge.
   4. Finish: Manufacturer's standard finishes with abrasive admixture.
   5. Manufacturer's standard colors: See Drawings for color selections.

C. Glazed Wall Tile: Provide flat tile complying with the following requirements:
   1. Thickness: 5/16-inch Nominal.
   2. Tile Dimensions: 4 inches by 8 inches.
   3. Face: Plain with cushion edge.
   4. Finish: Manufacturer's standard finishes.
   5. Manufacturer's standard colors: See Drawings for color selections.

D. Shapes and Trim: Selected from manufacturer's standard shapes and trim units:
   1. Trim Units: Provide tile trim units to match characteristics of adjoining flat tile and to comply with following requirements:
   2. Size: As indicated, coordinated with sizes and coursing of adjoining flat tile where applicable.
   5. Internal Corners: Field-butted square corners, except use coved base and cap angle pieces designed to member with stretcher shapes.

2.4 SETTING MATERIALS


C. Latex-Portland Cement Mortar: ANSI 118.4, composition as follows:
   1. Prepackaged dry mortar mix composed of Portland cement, graded aggregate, and manufacturer’s standard dry polymer additive in the form of a re-emulsifiable powder to which only water is added at the job site.

D. Organic Adhesive: ANSI A136.1, Type I, water resistant, organic type.
E. Water: Clean, potable.

2.5 GROUTING MATERIALS

A. Latex-Portland Cement Grout: ANSI A118.6, Portland cement, latex additive, and water; latex-Portland cement type; un-sanded.
   1. Latex additive (water emulsion) serving as replacement for part or all of gaging water, added at job site with dry grout mixture, with type of latex and dry grout mix as follows:
   2. Latex Type: Manufacturer’s standard.

B. Sand-Portland Cement Grout: ANSI A108.10, composed of white or gray cement and white or colored aggregate as required to produce color indicated.

C. Commercial Portland Cement Grout: ANSI 118.6, color as selected.

D. Dry Grout Mixture: Dry-set specified or supplied by latex additive manufacturer. Use latex additive without retarder with dry-set grout.
   1. Dry Grout Mixture: Commercial Portland cement specified or supplied by latex additive manufacturer.

E. Color Admixture: Cementitious type, color as specified; Standard and Designer Series as manufactured by Custom Building Products, or approved equal.

F. Application: Use commercial Portland cement grout combined with latex additive for grouting joints in floor tile unless otherwise indicated.

2.6 MISCELLANEOUS MATERIALS

A. Thresholds: Solid surface type, color to coordinate with floor tile, smooth finish, maximum 1/2 inch high by width of jamb by full width of wall or frame opening, beveled as indicated on Drawings, radiused edges from bevel to vertical face.

2.7 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with requirements of referenced standards and manufacturers including those for accurate proportioning of materials, water, or additive content; type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortars and grouts of uniform quality with optimum performance characteristics for application indicated.

2.8 WATERPROOFING FOR THINSET TILE INSTALLATIONS

A. Chlorinated Polyethylene Sheet (on interior concrete over occupied spaces): Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030-inch (0.76-mm) nominal thickness.
   1. Available Products: Subject to compliance with requirements, products which may be incorporated in the Work include, but are not limited to, the following:
      a. Noble Company (The); Nobleseal TS.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and areas where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.

B. Level and smooth subfloor, incorporating slopes as required on Drawings. Sand or grind protrusions, bumps, and ridges. Patch and repair cracks and rough areas. Fill depressions.

C. Verify that substrates for setting tile are firm, dry, clean, and free from oil or waxy films and curing compounds.

D. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.

E. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Blending: For tile exhibiting color variations within the ranges selected during sample submittals, verify that tile has been blended in factory and packaged accordingly so that tile units taken from one package show the same range in colors as those taken from other packages and match approved samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 INSTALLATION, GENERAL

A. TCA Installation Guidelines: TCA "Handbook for Ceramic Tile Installation"; comply with TCA installation methods indicated.

B. Extend tile work into recesses and under or behind equipment and fixtures to form a complete covering without interruptions except as otherwise shown. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so that plates, collars, or covers overlap tile.

D. Jointing Pattern: Unless otherwise shown, lay tile in grid pattern. Align joints when adjoining tiles on floor, base, walls, and trim are same size. Lay out tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths unless otherwise shown.

E. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so that extent of each sheet is not apparent in finished work.

F. Lay out tile wainscots to next full tile beyond dimensions indicated.
G. Expansion Joints: Locate expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated during installation of setting materials, mortar beds, and tile. Do not saw cut joints after installation of tiles.

H. Locate joints in tile surfaces directly above joints in concrete substrates.

3.4 CLEANING AND PROTECTION

A. Cleaning: Upon completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

B. Remove latex-Portland cement grout residue from tile as soon as possible.

C. Unglazed tile may be cleaned with acid solutions only when permitted by tile and grout manufacturer's printed instructions, but no sooner than 14 days after installation. Protect metal surfaces, cast iron, and vitreous plumbing fixtures from effects of acid cleaning. Flush surface with clean water before and after cleaning.

D. Finished Tile Work: Leave finished installation clean and free of cracked, chipped, broken, unbonded, and otherwise defective tile work.

E. Provide final protection and maintain conditions in a manner acceptable to manufacturer and installer that ensure that tile is without damage or deterioration at time of Substantial Completion.

F. When recommended by tile manufacturer, apply a protective coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.

G. Prohibit foot and wheel traffic from tiled floors for at least 7 days after grouting is completed.

H. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

3.5 INSTALLATION SCHEDULE

A. General: Install tile according to most current edition of the TCNA Handbook using method numbers as indicated below.


END OF SECTION 09300
SECTION 095123 - ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Acoustical panel ceilings.
B. Suspended metal grid ceiling system and perimeter trim.

1.3 RELATED SECTIONS

A. Section 07210 - Building Insulation: Acoustical batt insulation.
B. Section 09250 – Gypsum Board: Suspended gypsum board ceilings.
C. Division 15 Sections: For sprinkler heads, grilles, registers, and diffusers in acoustical ceilings.
D. Division 16 Section: For lighting fixtures in acoustical ceilings.
E. Section 018113 – Sustainability requirements

1.4 SUBMITTALS

A. Product Data: For each type of product specified, including the following:
   1. Ceiling suspension members.
B. Samples: For verification purposes of each type of exposed finish required, prepared on samples of size indicated below and of same thickness and material indicated for final unit of Work.
   1. Twelve-inch-square samples of each acoustical tile type, pattern, and color.
   2. Set of 12-inch-long samples of suspension system members.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of acoustical ceiling tile and supporting suspension system through one source from a single manufacturer.
B. Fire-Test-Response Characteristics: Provide acoustical tile ceilings that comply with the following requirements:
   1. Surface-Burning Characteristics: Provide acoustical tiles with the following surface-burning characteristics complying with ASTM E1264 for Class A materials as determined by testing identical products per ASTM E84:
a. Smoke-Developed Index: 50 or less.

C. Seismic Standard: Provide acoustical tile ceilings designed and installed to withstand the effects of earthquake motions according to requirements of authorities having jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical ceiling units to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical ceiling units, permit them to reach room temperature and a stabilized moisture content.

C. Handle acoustical ceiling units carefully to avoid chipping edges or damaging units in any way.

1.7 PROJECT CONDITIONS

A. Install acoustical units after interior wet work is dry.

1.8 EXTRA MATERIALS

A. Deliver extra materials to Owner. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with appropriate labels.

1. Ceiling Units: Furnish quantity of full-size units equal to 2.0 percent of amount installed.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Recycled Content: Provide acoustical panels with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 35 percent by weight.

B. VOC Content: Sealants applied on-site on the interior of the building and products used on the interior of the building shall comply with VOC limits as specified below.

1. Use materials that have the minimum VOC content in units of g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.2 ACOUSTICAL PANELS, GENERAL

A. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.

1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface per ASTM E 795.
B. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

2.3 MANUFACTURERS

A. Basis-of-Design Product: The design for the suspended ceiling tile systems is based on the manufacturer identified below. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
2. Chicago Metallic Corporation.
4. USG Interiors, Inc.
5. Substitutions: In accordance with Section 01630.

   1. Item Number: 3251.
   2. Classification: Type XII, Form 2, Pattern E.
   5. Composition: Wet-formed mineral fiber.
   6. NRC Range: 0.95.
   7. CAC: N/A.
   11. Suspension System: Silhouette XL 9/16” Bolt Slot.

   1. Item Number: 1936.
   2. Classification: Type IV, Form 2, Pattern E.
   4. Thickness: 3/4-inches.
   5. Composition: Wet-formed mineral fiber.
   6. NRC Range: 0.70.
   7. CAC: 38.
   11. Suspension System: Silhouette XL 9/16” Bolt Slot with 1/8” reveal grid.

2.4 SUSPENSION SYSTEM COMPONENTS

A. Suspension System: ASTM C635, Armstrong World Industries, Inc., Silhouette XL.
   1. Exposed Grid Surface Width: 9/16-inch, with reveal grid where specified.
   3. Finish: White, low gloss baked enamel finish, color to match ceiling tiles exactly.

B. Suspension System for ACT-3: Armstrong World Industries, Inc – Metalworks System
   1. Standard Carrier system Item number 5497.
2. Provide splices and hangers as recommended by mfr.
3. Any exposed reveals to be black.
4. Any exposed edge trims to be covered in black filler strip.

C. Attachment Devices: Size for 5 times design load indicated in ASTM C635, Table 1, Direct Hung, double web, Intermediate-Duty System, unless otherwise indicated.

D. Wire for Hangers and Ties: ASTM A641, Class 1 zinc coating, soft temper.
   1. Gage: Provide wire sized so that stress at 3 times hanger design load (ASTM C635, Table 1, Direct-Hung) will be less than yield stress of wire, but provide not less than 0.106-inch diameter (12-gage).

E. Support Hangers and Channels: Mild steel, zinc coated, or protected with rust-inhibitive paint, size and shape to suit application and seismic requirements.

F. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.
   1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners, unless otherwise indicated.
   2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
   3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

G. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

2.5 ACOUSTICAL SEALANT

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   1. Acoustical Sealant for Exposed and Concealed Joints:
      a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
      b. USG Corporation; SHEETROCK Acoustical Sealant.
   2. Acoustical Sealant for Concealed Joints:
      a. OSI Sealants, Inc.; Pro-Series SC-175 Rubber Base Sound Sealant.
      b. Pecora Corporation; BA-98.

B. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), complying with ASTM C834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E90.
C. Acoustical Sealant for Concealed Joints: Manufacturer's standard nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), recommended for sealing interior concealed joints to reduce airborne sound transmission.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and structural framing to which ceiling system attaches or abuts, with Installer present, for compliance with requirements specified in this and other sections that affect installation and anchorage of ceiling system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less-than-half-width units at borders, and comply with reflected ceiling plans.

3.3 INSTALLATION, GENERAL

A. General: Install acoustical panel ceilings to comply with seismic design requirements indicated, in accordance with manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Standard for Installation of Ceiling Suspension Systems: Comply with ASTM C636.

C. Arrange acoustical units and orient directionally patterned units (if any) in manner shown by reflected ceiling plans.

3.4 INSTALLATION, SUSPENSION SYSTEM

A. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system.

B. Splay hangers only where required, to miss obstructions; offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means.

C. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

D. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
E. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, post-installed mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.

F. Do not attach hangers to steel deck tabs.

G. Do not attach hangers to steel roof deck. Attach hangers to structural members.

H. Space hangers not more than 48-inches oc along each member supported directly from hangers, unless otherwise shown, and provide hangers not more than 8-inches from ends of each member.

I. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, kinked or otherwise damaged runners.

J. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post-installed anchors.

3.5 INSTALLATION OF ACOUSTICAL SEALANT

A. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

B. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

C. Screw attach moldings to substrate at intervals not more than 16-inches (400 mm) oc and not more than 3-inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8-inch in 12-feet (3.2 mm in 3.66 m). Miter corners accurately and connect securely.

D. Do not use exposed fasteners, including pop rivets, on moldings and trim.

3.6 INSTALLATION, CEILING TILES

A. Install units after above-ceiling work is complete.

B. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

C. Install acoustical tile in coordination with suspension system and exposed moldings and trim. Place splines or suspension system flanges into kerfed edges so that every tile-to-tile joint is closed by double lap of material.

D. Install acoustical units level, in uniform plane, and free from twist, warp and dents.

E. Arrange directionally patterned acoustical tiles as follows:
1. As indicated on reflected ceiling plans.

F. Fit adjoining tile to form flush, tight joints and to fit irregular grid and perimeter edge trim. Scribe and cut for accurate fit at borders and around penetrating work.

G. Trim cut tiles at wall junctures so that tegular edges fit properly into grid and edge moldings. Trim edges of tegular tiles to match edges on untrimmed sides as indicated on Drawings. Paint cut edges to match ceiling tile face.

H. Conform to State safety orders and applicable codes, including the seismic bracing requirements of CBC.

I. Lay acoustical insulation for a distance of 48-inches either side of acoustical partitions where indicated on Drawings.

3.7 CLEANING

A. Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch-up of minor finish damage.

B. Remove and replace work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09510
SECTION 09 65 00 - RESILIENT FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Linoleum sheet flooring.
B. Rubber sheet flooring, stair treads and accessories.
C. Resilient wall base, reducer strips, and other accessories.

1.3 RELATED SECTIONS

A. Section 09980 – Vapor Emission Treatment Systems.
B. Section 018113 – Sustainability Requirements

1.4 SUBMITTALS

A. Product Data: For each type of product specified.
   1. Provide manufacturers' product data for adhesives, including printed statement of VOC content.
B. Shop Drawings: Show locations of all seams, whether deviating from seam locations indicated on Drawings or not.
C. Samples for Verification: In manufacturer's standard size, but not less than 6-by-9-inch (150-by-230-mm) sections of each different color and pattern of floor covering required.
   1. For heat-welding bead, manufacturer's standard-size Samples, but not less than 9-inches (230 mm) long, of each color required.

1.5 QUALITY ASSURANCE

A. Single-Source Responsibility for Flooring: Obtain each type, color, and pattern of resilient flooring from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.
B. Manufacturer: Provide resilient flooring manufactured by a firm with a minimum of 10 years’ experience with resilient flooring of type’s equivalent to those specified. Manufacturers proposed for use, which are not named in this section, shall submit evidence of ability to meet performance requirements specified not less than 10 days prior to bid date.
C.

D. Fire Performance Characteristics: Provide resilient flooring with the following fire performance characteristics as determined by testing products per ASTM test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
   1. Critical Radiant Flux: 0.45 watts per sq.cm or more per ASTM E648.
   2. Smoke Density: Less than 450 per ASTM E662.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver resilient flooring and installation accessories to Project site in original manufacturer's unopened cartons and containers each bearing names of product and manufacturer, Project identification, and shipping and handling instructions.

B. Store flooring materials in dry spaces protected from the weather with ambient temperatures maintained between 50 deg F (10 deg C) and 90 deg F (32 deg C).

C. Move flooring and installation accessories into spaces where they will be installed at least 48 hours in advance of installation.

1.7 PROJECT CONDITIONS

A. Maintain a minimum temperature of 68 deg F (20 deg C) in spaces to receive flooring for at least 48 hours prior to installation, during installation, and for not less than 72 hours after installation. After this period, maintain a temperature of not less than 55 deg F (13 deg C).

B. Do not install flooring until it is at the same temperature as the space where it is to be installed.

C. Close spaces to traffic during installation.

D. Close spaces to traffic for 48 hours after floor covering installation.

E. Install resilient products after other finishing operations, including painting, have been completed.

F. All existing slabs, transitions, slopes, etc. shall be adequately treated, flattened, prepared and made ready for resilient flooring.

1.8 SEQUENCING AND SCHEDULING

A. Install flooring and accessories after other finishing operations, including painting, have been completed.

B. Install flooring adequately in advance of scheduled occupancy of each Phase of the project to assure proper curing of adhesives prior to allowing foot traffic on flooring.
C. Do not install sheet vinyl floor coverings over concrete slabs until the slabs have cured and are sufficiently dry to bond with adhesive as determined by floor covering manufacturer's recommended bond and moisture test.

1.9 EXTRA MATERIALS

A. Deliver extra materials to Owner. Furnish extra materials matching products installed as described below, packaged with protective covering for storage and identified with labels clearly describing contents.

B. Furnish not less than 10 linear feet for each 500 linear feet or fraction thereof, in roll form of each different composition, wearing surface, color, and pattern of sheet vinyl flooring and 50 lineal feet of resilient base material of each color and size.

1.10 WARRANTY

A. Provide current, detailed manufacturer's warranty for each flooring product as applicable, including limited wear, defect and conductivity.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Local/Regional Materials: Give preference to manufacturer’s whose facilities are within a 500 mile radius of the project site. Also give preference to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

B. VOC Content: Adhesives, sealants, paints, welding, and coatings applied on-site on the interior of the building and products used on the interior of the building shall comply with VOC limits as specified below.
   1. Use materials that have the lowest possible VOC content in units of g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Recycled Content: Use materials and products that contain the maximum amount of recycled content allowed that retains material integrity.

D. Rapidly Renewable Materials: Harvested within a 10-year or shorter cycle.

E. Low Emitting Materials: Provide resilient flooring installed on the interior of the building that meets the testing and product requirements for certification by FloorScore.

2.2 LINOLEUM SHEET FLOORING

A. Manufacturers
   1. Basis-of-Design Product: The design for the resilient flooring is based on the manufacturer identified below. Subject to compliance with requirements, provide the named product or a comparable product by one of the following. Refer to drawings for color and texture selection for basis of design:
3. Armstrong World Industries, Inc.
4. Azrock Commercial Flooring, DOMCO.

B. Sheet Linoleum: ASTM F2034; homogeneous sheet linoleum of primarily natural materials consisting of linseed oil, wood flour, and rosin binders, mixed and calendered onto natural jute backing, with pattern and color extending throughout total thickness of material.
   1. Width: 79-inches.
   2. Thickness: 1/10-inch.
   3. Slip Resistance: In accordance with ADA recommendation of .6 for flat surfaces.
   4. Static Load Limit: ASTM F970, 450 lb/sq in.
   5. Fire Resistance
      a. Smoke Density: ASTM E622, 450 or less.
   6. Style and Color: As indicated on Drawings.

2.3 RUBBER BASE

A. Manufacturers
   1. Basis-of-Design Product: The design for the resilient flooring is based on the manufacturer identified below. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
   2. Forbo Industries, Inc.
   3. Nora

B. Resilient Wall Base: ASTM F1861, Type TS (rubber, vulcanized thermoset).
   1. Manufacturer: Armstrong World Industries, Inc.
   4. Minimum Thickness: 0.125-inch (3.2 mm).
   5. Height: 4-inches (102 mm).
   7. Outside Corners: Premolded.
   8. Inside Corners: Premolded.
   10. Color: As selected by Architect from manufacturer's full range.

2.4 ACOUSTICAL UNDERLAYMENT

A. Manufacturer: Amorim Industrial Solutions, 800-225-2675.

B. Roll Materials: AcoustiCORK R60 underlayment, pure granulated cork combined with a polyurethane resin binder.
   1. Dimensions: 4-foot by 100-foot (1.22m by 30.48m) roll.
   2. Thickness: 0.24-inch (6mm).

C. Perimeter Isolation Barrier: B-60 AcoustiCORK, consisting of pure granulated cork combined with a polyurethane resin binder, with peel and stick tape adhered to one side of the barrier.
   1. Dimensions: 3/4-inch by 25-foot (19mm by 6.25m) roll.
2. Thickness: 0.24 inch (6mm).

2.5 INSTALLATION ACCESSORIES

A. Concrete Slab Primer: Nonstaining type as recommended by flooring manufacturer.

B. Adhesives (Cements): Water-resistant type recommended by tile manufacturer to suit resilient floor tile products and substrate conditions indicated.
   1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24 and South Coast Air Quality Management District Rule #1168).
      a. Cove Base Adhesives: 50 g/L.


D. Edge Strips: Burke/Mercer Flooring Products or Roppe; rubber, carpet-to-resilient flooring strips; color to be selected.

E. Floor Polish: Provide protective liquid floor polish products as recommended by manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. General: Examine areas where installation of flooring will occur, with Installer present, to verify that substrates and conditions are satisfactory for resilient flooring installation and comply with manufacturer's requirements and those specified in this Section.

B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F710 and the following:
   1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials whose presence would interfere with bonding of adhesive. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by tile manufacturer.
   2. Finishes of subfloors comply with tolerances and other requirements specified in Section 03300 for slabs receiving resilient flooring.

C. Verify adhesives are compatible with concrete curing compounds on slabs. Where adhesive is found not to be compatible, remove curing compound prior to installation of material.

3.2 PREPARATION

A. General: Comply with manufacturer's installation specifications to prepare substrates indicated to receive flooring.

B. Concrete Substrates: Prepare according to ASTM F710.
   1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   2. Provide vapor emission treatment system, see Section 09980.
3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.

4. Moisture Testing:
   a. Perform anhydrous calcium chloride test, ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
   b. Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.

C. Use trowelable leveling and patching compounds per manufacturer's directions to fill cracks, holes, and depressions in substrates.

D. Remove coatings, including curing compounds, and other substances that are incompatible with flooring adhesives and that contain soap, wax, oil, or silicone, by using a terrazzo or concrete grinder, a drum sander, or a polishing machine equipped with a heavy-duty wire brush.

E. Broom or vacuum clean substrates to be covered by resilient flooring immediately before tile installation. Following cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust.

F. For all areas to receive resilient flooring, both over new and existing concrete floor slabs, prepare concrete with vapor emission treatment system, see Section 09980. Confirm compatibility of resilient flooring adhesive with vapor emission treatment system prior to install.

G. Apply concrete slab primer, if recommended by flooring manufacturer, prior to applying adhesive. Apply according to manufacturer's directions. Confirm compatibility with vapor emission treatment system.

3.3 ACOUSTICAL UNDERLAYMENT INSTALLATION

A. General: Comply with underlayment manufacturer’s written instructions.

B. Perimeter Isolation Barrier:
   1. Install vertically around the perimeter of the entire floor, including any openings in the sub floor installation. Remove the release liner from the self-adhesive backing and place flat against the wall flush to the floor. After positioning, press the barrier firmly into place.
   2. After the finished floor is installed, trim the isolation barrier flush with the finished floor surface.
   3. If wall base is specified for a tile installation, place a tile spacer between the base and the finished floor. Adhere the base to the wall, keeping the base approximately 1/8-inch to 1/4-inch (3 to 6mm) off the finished floor. Remove the spacer when the adhesive has cured.
   4. Caulk the space with a bead of non-hardening, paintable caulk.

C. Cork Underlayment Installation:
   1. Cut cork underlayment to desired length and install directly over the properly prepared floor substrate.
2. Install directly over subfloor, placing sheet or roll materials tight to the perimeter isolation barrier. Glue the cork underlayment to the subfloor with a multi-purpose latex based, Type I organic adhesive and roll to remove all trapped air. Loose lay when an overlay is used as recommended by manufacturer. Tightly butt joints together.

D. Never mechanically fasten the cork underlayment with screws, nails or staples, as this will severely diminish the acoustical value of the sound rated floor system.

3.4 FLOOR COVERING INSTALLATION

A. General: Comply with floor covering manufacturer's installation instructions and other requirements indicated that are applicable to each type of floor covering installation included in Project.

B. Resilient flooring must be “wet-set” in adhesive within 10-15 minutes after application of the adhesive. Do not apply adhesive before linoleum pieces have been properly measured, cut, and prepared for application. Do not apply more adhesive than required for prepared linoleum.

C. Scribe and cut floor coverings to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings.

D. Unroll sheet floor coverings and allow them to stabilize before cutting and fitting.

E. Extend floor coverings into toe spaces, door reveals, closets, and similar openings.

F. Maintain reference markers, holes, or openings that are in place or marked for future cutting by repeating on floor coverings as marked on subfloor. Use chalk or other nonpermanent marking device.

G. Install floor coverings on covers for telephone and electrical ducts and similar items in finished floor areas. Maintain overall continuity of color and pattern with pieces of floor coverings installed on covers. Tightly adhere floor covering edges to substrates that abut covers and to cover perimeters.

H. Lay out sheet floor coverings as follows:
   1. Maintain uniformity of floor covering direction. Install one sheet at a time.
   2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches (152 mm) away from parallel joints in floor covering substrates.
   3. Match edges of floor coverings for color shading at seams.
   4. Avoid cross seams.
   5. Eliminate deformations that result from hanging method used during drying process (stove bar marks).

I. Adhesive Material Installation: Use trowel as recommended by flooring manufacturer for specified adhesive. Spread at rate of approximately 150 sq ft/gallon as recommended by flooring manufacturer.
J. Adhere floor coverings to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

K. Comply with floor covering manufacturer's directions including those for trowel notching, adhesive mixing, and adhesive open and working times.

L. Hand-roll flooring in both directions from center out to embed floor coverings in adhesive and eliminated trapped air. At walls, door casings, and other locations where access by roller is impractical, press floor coverings firmly in place with flat-bladed instrument.

M. Heat-Welded Seams: Comply with ASTM F1516. Rout joints and use welding bead to permanently fuse sections into a seamless floor covering. Prepare, weld, and finish seams to produce surfaces flush with adjoining floor covering surfaces.

3.5 RUBBER BASE INSTALLATION

A. Apply wall base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

B. Install wall base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.

C. Tightly adhere wall base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

D. Do not stretch wall base during installation.

E. Fit joints tight and vertical. Maintain minimum measurement of 24-inches between joints.

F. Miter internal corners. At external corners, 'V' cut back of base strip to 2/3 of its thickness and fold. At exposed ends use premolded units.

G. Install base on solid backing. Bond tight to wall and floor surfaces.

H. Scribe and fit to door frames and other interruptions.

I. Where base wraps around columns, ensure that seams are terminated with a mitered joint at the corners of the column. Offset, asymmetrical seams are not permissible.

3.6 CLEANING AND PROTECTION

A. Perform the following operations immediately after completing flooring installation:

1. Remove visible adhesive and other surface blemishes using cleaner recommended by flooring manufacturers.

2. Sweep or vacuum floor thoroughly.

3. Do not wash floor until after time period recommended by resilient flooring manufacturer.

4. Damp-mop floor to remove black marks and soil.
B. Protect floor coverings against mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods indicated or recommended in writing by manufacturer.
   1. Apply protective floor polish to surfaces that are free of soil, visible adhesive, and surface blemishes.
      a. Seal flooring as recommended by manufacturer but with not less than two coats of floor polish.
      b. Use commercially available product acceptable to manufacturer.
      c. Coordinate selection of floor polish with Owner's maintenance service.
   2. Cover floor coverings with undyed, untreated building paper until inspection for Substantial Completion.
      a. Allow drying room film (yellow film caused by linseed oil oxidation) to disappear before Substantial Completion.
   3. Do not move heavy and sharp objects directly over floor covering surfaces. Place plywood or hardboard panels over floor coverings and under objects while they are being moved. Slide or roll objects over panels without moving panels.

C. Reapply floor polish after cleaning.

END OF SECTION 09650
SECTION 096813 - CARPET TILE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Modular, non-indexed, carpet tile.
B. Walk off carpet tile

1.3 RELATED SECTIONS

A. Section 09650 – Resilient Flooring: Resilient wall base and accessories installed with carpet tile.
B. Section 09980 – Vapor Emission Treatment Systems.
C. Section 018113 – Sustainability requirements

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer's written data on physical characteristics, durability, and fade resistance. Include installation recommendations for each type of substrate.

B. Samples for Verification: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
   2. Exposed Edge, Transition, and other Accessory Stripping: 12-inch- (300-mm-) long Samples.

C. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

D. Qualification Data: For Installer.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency.

F. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
   1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

G. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.

B. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 2, as determined by testing identical products per ASTM E648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

C. Carpet Low-VOC Emissions: Provide carpet tile materials that have been tested and certified to indicate carpet tile, carpet backings, and adhesives emit no or low VOCs (volatile organic compounds). Provide products carrying the following certifications:
   1. CRI Green Label Plus.

D. Mockups: Before installing carpet tile, build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
   2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
   3. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   4. Approved mockups may become part of the completed Work if undamaged at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI 104, Section 5, "Storage and Handling."

1.7 PROJECT CONDITIONS

A. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."

B. Environmental Limitations: Do not install carpet tiles until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
1.8 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
   1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
   2. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, dimensional stability, excess static discharge, and delamination.
   3. Warranty Period: 10 years from date of Substantial Completion.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd. (8.3 sq. m).

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Low Emitting Materials: Provide carpet tile installed on the interior of the building that meets the testing and product requirements of the Carpet and Rug Institute’s Green Label Plus program.

B. Local/Regional Materials: Give preference to manufacturer’s whose facilities are within a 500 mile radius of the project site. Also give preference to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

C. VOC Content: Adhesives, sealants, paints, welding, and coatings applied on-site on the interior of the building and products used on the interior of the building shall comply with VOC limits as specified below.
   1. Use materials that have the lowest possible VOC content in units of g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.2 CARPET TILE AND WALK OFF CARPET TILE

A. Basis-of-Design Product: The design for the carpet tile is based on the manufacturer identified below. Subject to compliance with requirements, provide the named product or a comparable product by one of the following. Comparable shall mean in quality, material, color, texture, and opinion of architect:
   1. Basis-of-Design: Interface Flooring
   2. Shaw
   3. Bentley Prince Street.
   4. Lees Carpets.
B. Carpet Tile:
   1. VOC Limits: Provide carpet tile that complies with the following limits for VOC content when tested according to ASTM D5116:
      a. Total VOCs: 0.5 mg/sq. m x h.
      b. 4-PC (4-Phenylcyclohexene): 0.05 mg/sq. m x h.
      c. Formaldehyde: 0.05 mg/sq. m x h.
      d. Styrene: 0.4 mg/sq. m x h.
   2. Color: As indicated on Drawings.
   3. Pattern: As indicated on Drawings.

C. Auxiliary Materials:
   1. Edge guards.
   2. Adhesives, cements and fasteners.

2.3 INSTALLATION ACCESSORIES

A. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.
   1. VOC Limits: Provide adhesives that comply with the following limits for VOC content when tested according to ASTM D 5116:
      a. Total VOCs: 10.00 mg/sq. m x h.
      b. Formaldehyde: 0.05 mg/sq. m x h.
      c. 2-Ethyl-1-Hexanol: 3.00 mg/sq. m x h.

B. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance. Examine carpet tile for type, color, pattern, and potential defects.

B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F710 and the following:
   1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer.
   2. Subfloor finishes comply with requirements specified in Division 3 Section "Cast-in-Place Concrete" for slabs receiving carpet tile.
   3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
   4. Provide vapor emission treatment system, see Section 09980.

C. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION

A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider and protrusions more than 1/32 inch (0.8 mm), unless more stringent requirements are required by manufacturer's written instructions.

C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.

D. For all areas to receive carpet tile, both over new and existing concrete floor slabs, prepare concrete with vapor emission treatment system, see Section 09980. Confirm compatibility of carpet tile adhesive with vapor emission treatment system prior to install.

E. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.

B. Installation Method: As recommended in writing by carpet tile manufacturer.

C. Maintain dye lot integrity. Do not mix dye lots in same area.

D. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.

E. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.

G. Install pattern parallel to walls and borders.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet tile:
   1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
   2. Remove yarns that protrude from carpet tile surface.

B. Protect installed carpet tile to comply with CRI 104, Section 16, "Protection of Indoor Installations."

C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 09681
SECTION 099113 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All provisions of the Contract Documents apply to this Section. The Contractor for this Section shall be responsible for complete familiarity with same.

B. Related Sections:
   1. Section 018113 – Sustainability Requirements

1.2 SCOPE OF WORK

A. Preparation of surfaces for painting and finishing and for the painting and finishing of all exposed surfaces to receive one of the applications specified in the Section.

1.3 WORK NOT INCLUDED OR SPECIFIED IN OTHER SECTIONS

A. Shop priming specified in other Sections.

B. Copper, brass, aluminum, stainless steel and other non-ferrous metals shall not be painted unless specifically noted otherwise.

1.4 SUMMARY

A. This Section includes surface preparation and the application of paint systems on the following exterior substrates:
   1. Concrete.
   2. Concrete masonry units (CMU).
   3. Steel.
   5. Wood.

1.5 SUBMITTALS

A. Before materials are ordered, submit a complete list of proposed materials for each type of product listed. When requested, submit product data and a complete specifications and samples of materials for approval.

B. Samples:
   1. Color schedule will be furnished by the Architect prior to commencement of painting work, and from this the painting contractor shall prepare duplicate set of samples of treatments for all major surfaces.
2. Samples shall each be made on material like that to be treated and the material shall be positioned, during execution of the sample, to simulate the job conditions, i.e., vertical, overhead horizontal, or below eye level horizontal.

3. When approved, samples will be so marked, with one set retained by Architect and one by painting contractor. Approved sample shall be strictly duplicated in the work. Additional coats, if required to reproduce approved samples, shall be applied by the Contractor without additional cost to the Owner.

1.6 QUALITY ASSURANCE

A. Codes and Standards: Comply with pertinent codes and regulations.

1.7 EXTRA MATERIALS

A. Provide Owner, at completion of job, with one (1) gallon (3.8L) of paint in each color selected. Paint to be supplied in full tightly sealed containers labeled with color numbers as listed in the final color schedule.

PART 2 - PRODUCTS

2.1 PAINT, GENERAL

A. Material Compatibility:
   1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. Colors: As indicated in a color schedule.

2.2 MATERIALS

A. All paint, varnish, enamel, lacquer, and related materials shall be first quality standard products of established manufacturers who have continuous performance in the manufacture of each product for 10 years and approved by the Architect. Provide best quality, first line grade of various types of coatings as regularly manufactured by acceptable paint materials manufacturers. Materials not displaying manufacturer's identification as a standard, best-grade, first line product will not be acceptable. The following manufactures are acceptable:

   1. Benjamin-Moore
   2. Pratt & Lambert
   3. Sherwin-Williams
   4. Porter Paint Company
B. Epoxy coatings shall be manufactured by Porter Paint Company. Epoxy coating colors shall not necessarily be selected from manufacturer's standard colors.

C. All materials shall be delivered to the site in unopened original containers, bearing the brand name and the manufacturer's name, and having seals intact. Containers shall not be opened until contents are ready to be used.

D. No materials shall be reduced or changed except as indicated by manufacturer's directions on containers.

E. Thinners and dryers shall be added only in accordance with the manufacturer's printed instructions. Paints with solids shall be mixed at least 24 hours before use and shall be re-mixed before application. Turpentine shall conform to ASTM Standard Specifications D-13.

F. In selecting painting materials, the Contractor shall take into consideration special atmospheric conditions prevailing and any excessive treatment to which the particular surfaces might be subject.

G. All latex paints specified shall be 100% latex base.

2.3 EXTERIOR PAINTING SCHEDULE

A. Concrete, Stucco, and Masonry (Other Than Concrete Masonry Units) (Satin): (Latex System).
   1. Finish Coats: Satin Latex, (5-19 units at 60 degrees F.), 1.4 to 1.6 mils DFT/coat.
   2. Manufacturers:
      b. Devoe Paint Co., Mirrolac-WB Semi-Gloss Enamel, DP83XX
      c. Porter Paints Co., #2809 PorterGuard DTM Acrylic Satin
      d. Coronado Paint Co., #410 Gold Crylicote Acrylic Satin

B. Concrete Masonry Units (Semi-Gloss): (Latex System)
   2. Manufacturers:
      a. Sherwin Williams Co., HD Block Filler B42W 46
      b. Devoe Paint Co., Bloktex Heavy Duty Acrylic Blockfiller, DP89301
      c. Porter Paints Co., #9203 Quick Fill 900 Interior/Exterior Latex Block Filler
      d. Coronado Paint Co., #946-11 Superkote 5000 Latex Block Filler
   3. Finish Coats: Latex, Semi-Gloss (20-30 units at 60 degrees F.), 1.3 to 1.5 mils DFT/Coat.
   4. Manufacturers:
      a. Sherwin Williams Co., A100 Latex Semi-gloss A8 series
      b. Devoe Paint Co., Wonder-Shield Semi-gloss Acrylic House, DR17XX
      c. Porter Paints Co., #6029 Acri-Pro 100 Semi-Gloss Exterior Acrylic
      d. Coronado Paint Co., #12 Supreme Semi-Gloss Acrylic

C. Metal – Ferrous (Semi-Gloss): (Acrylic Latex System)
1. Primer: 100 percent Acrylic, Waterborne, Corrosion Resistant Primer, 3.0 mils/coat.

2. Manufacturers:
   a. Sherwin Williams Co., DTM Primer/Finish B66 series
   b. Devoe Paint Co., Mirrolac-WB DTM Flat Primer & Finish, DP8502
   c. Porter Paints Co., #212 Porter-Guard DTM Acrylic Primer/Finish
   d. Coronado Paint Co., #180-11 Acrylic Metal primer

3. Finish Coats: 100 percent Acrylic, Waterborne, Semi-Gloss (30-40 units at 60 degrees F.), 3.0 mils DFT/coat.

4. Surfaces: Miscellaneous ferrous metal.

5. Manufacturers:
   b. Devoe Paint Co., Mirrolac-WB Semi-Gloss Enamel, DP83XX
   c. Porter Paints Co., #2809 PorterGuard DTM Acrylic Satin
   d. Coronado Paint Co., #90 Rust Scat Acrylic Semi-Gloss

D. Metal – Ferrous (Gloss): (Acrylic Latex System)

1. Primer: 100 percent Acrylic, Waterborne, Corrosion Resistant Primer, 3.0 mils/coat.

2. Manufacturers:
   b. Devoe Paint Co., Mirrolac-WB DTM Flat Primer & Finish, DP8502
   c. Porter Paints Co., #212 Porter-Guard DTM Acrylic Primer/Finish
   d. Coronado Paint Co., #180-11 Acrylic Metal primer

3. Finish Coats: 100 percent Acrylic, Waterborne, Semi-Gloss (30-40 units at 60 degrees F.), 3.0 mils DFT/coat.

4. Manufacturers:
   a. Sherwin Williams Co., DTM Acrylic Semi-Gloss B66100
   b. Devoe Paint Co., Mirrolac-WB Gloss Enamel, DP84XX
   c. Porter Paints Co., #2909 PorterGuard DTM Acrylic Gloss
   d. Coronado Paint Co., #80 Rust Scat Acrylic Gloss

5. Surfaces: Miscellaneous ferrous metal.

E. Metal – Galvanized (Semi-Gloss): (Acrylic Latex System)

1. Primer: 100 percent Acrylic, Waterborne, Corrosion Resistant Primer, 3.0 mils/coat.

2. Manufacturers:
   a. Sherwin Williams Co., DTM Primer/Finish B66-200 series
   b. Devoe Paint Co., Mirrolac-WB DTM Flat Primer & Finish, DP8502
   c. Porter Paints Co., #2809 Porter-Guard DTM Acrylic Satin
   d. Coronado Paint Co., #90 Rust Scat Acrylic Semi-Gloss

F. Metal – Galvanized (Gloss): (Acrylic Latex System)

1. Primer: 100 percent Acrylic, Waterborne, Gloss (60-80 units at 60 degrees F.), 3.0 mils DFT/coat.
2. Manufacturers:
   a. Sherwin Williams Co., DTM Gloss B66100
   b. Devoe Paint Co., Mirrolac-WB DTM Flat Primer & Finish, DP8502 Mirrolac-WB Gloss Enamel, DP84XX
   c. Porter Paints Co., #2909 PorterGuard DTM Acrylic Gloss
   d. Coronado Paint Co., #80 Rust Scat Acrylic Semi-Gloss

G. Metal – Heat Resistant: (Maximum Temperature 1,000 degrees F.) (VOC 650)

1. Primer: Silicone Alkyd, Aluminum Bright, .75 mils DFT/coat.
2. Finish Coats: Silicone Alkyd, Aluminum Bright, .75 – 1.0 mils DFT/coat.
3. Manufacturers:
   a. Sherwin Williams Co., Silver Brite Hi-Heat Silicone Aluminum B59S8
   b. Devoe Paint Co., HT-10 Modified Silicone High Heat Coating (aluminum), 710SXXX
   c. PPG Ind. High Performance Coatings, #UC46006 Silicone Acrylic Aluminum
   d. Coronado Paint Co., #206-145 Heat Resistant Aluminum
4. Surfaces: Stacks with temperature above 200 degrees F.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   1. Concrete: 12 percent.
   3. Wood: 15 percent.
   4. Plaster: 12 percent.
   5. Gypsum Board: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Before commencing work on surfaces of any type, the Painting Contractor shall carefully inspect same and satisfy himself that they are dry and in all other respects suitable to receive the
specified treatment. If the condition of any surface is such that it cannot be put in proper condition by normal preparatory methods, and arrangements for prompt correction cannot be made at once with the General Contractor, the Painting Contractor shall not undertake surface preparation and shall, instead, at once address a written request to the General Contractor for corrections which will provide an acceptable surface.

E. Application of any coating to a surface will constitute acceptance of the surface by the Painting Contractor. If after treatment, the completed finish (or any portion thereof) blisters, checks, peel, or otherwise shows indication of dampness or other irregular condition of surface, the Painting Contractor shall, at his own expense, remove the applied treatment and refinish the part affected to the satisfaction of the Architect. (The Painting Contractor should determine dryness of all moisture-holding materials by use of a reliable electronic moisture meter).

F. Each coat of material applied must be inspected and approved by the Architect before the application of the succeeding specified coat; otherwise, no credit for the concealed coat will be given and the Painting Contractor shall assume the responsibility to recoat the work in question. The Painting Contractor shall notify the Architect, when each coat is completed, for inspection.

3.2 USE OF PREMISES

A. No plumbing fixture, open waste, drain, or vent pipe (or other pipe of any kind), shall be used to dispose of paint materials, used rags, waste, or other materials.

B. New materials of all kinds, shall not be used as supports for planking and shall be thoroughly protected from damage at all times.

C. Provide, erect and maintain all staging and scaffolding required for execution of the work, move when necessary at the option of the Architect, to permit installation of other work. Remove from premises promptly at completion of work.

3.3 PREPARATION AND APPLICATION

A. Comply with manufacturer's written instructions and recommendations for preparation and application.

B. Before painting is started in an area, finish carpentry, including correction and adjustments shall have been completed, all glazing installed and the area of the building cleaned of all debris, thoroughly broom cleaned and dusted out. All plastering and drywall shall be finished and shall be thoroughly dry.

C. Finish hardware and plates for electric outlets shall have been fitted by the General and Electrical Contractors, and shall be removed by and replaced by the Painting Contractor.

D. Nail holes in all exposed woodwork shall be filled with putty colored to match accurately the approved finishes. Seal knots and pitch streaks before applying primer. Shellac on interior, spar varnish on exterior.
E. Sandpapering of all wood joints and exposed wood surfaces shall follow paint priming or wood stain application on natural finish work and shall precede second coat work. Sand only with the grain.

F. Metal surfaces shall be smooth and thoroughly cleaned of grease, rust, scale and dust. Shop coats that are marred or abraded shall be cleaned and touched up with primer matching the shop coat.

G. When part will be exposed to view, sandpaper the entire treated area smooth, feather the edge of surrounding undamaged prime coat, and extend spot priming onto same, in a manner to eliminate evidence of repair.

H. Before painting any metal, the surfaces shall be gone over carefully with body putty, if necessary, and sanded smooth.

I. Unless the prime coat material to be used is recommended by its manufacturer for application over zinc-coated surfaces of the type at hand, after cleaning and any necessary de-glossing, only, surfaces must be given phosphate pre-treatment prior to application of prime coat; usual "vinegar etch" or acid pre-treatment (wash) will not be permitted.

J. Phosphate Pre-Treatment: Crystalline zinc phosphate type; either "Lithoform", made by the American Chemical Paint Co., Ambler, Pa., or Galvaprep No. 5", made by Neilson Chemical Co., Detroit, Michigan as approved. Follow manufacturer's instructions and directions exactly, as to cleaning prior to treatment, application of treatment and after-rinse.

K. Concrete Block Masonry:

1. Prepare concrete block masonry surfaces by removing all efflorescence, dirt, rust, oil and grease stains, and method used shall be as determined by the Painting Contractor and paint manufacturer's representative. Surface must be acceptable before painting.

2. Before first paint coat is applied, spot prime any nails and other exposed metal occurring in the surfaces with an oil base masonry primer as recommended by the paint manufacturer, to insure against rust.

L. Plaster and drywall surfaces shall be sand-papered smooth, and scratches, cracks and abrasions shall be satisfactorily eliminated before priming. Spot seal "hot spots" after first coat has dried.

M. Storage for paint materials, preparation and mixing shall be in well-lighted and ventilated central location; but shall not be allowed on finished floor. Oily rags and waste must be removed from building every night, and must not be allowed to accumulate.

N. Dropcloths shall be generously used and shall be carefully placed and secured over floor areas as the paint work progresses.

O. Adequate safeguards shall be provided against damage from the escape of materials during spray operation. Except that stains may be applied by cloth or sponge, all coatings shall be applied by brush or roller unless spray application is specifically named as acceptable, in description of required treatment.

P. All adjoining surfaces, finish floors and fixtures shall be carefully protected throughout the painting operations against spray or splash stains, marks or other damage; and should such
defacement occur as a result of the work, it shall be corrected in a manner acceptable and satisfactory to the Architect and without added cost to the Owner.

Q. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.

R. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

S. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

T. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.4 WORKMANSHIP

A. All painting shall be done by skilled mechanics working under the supervision of a capable foreman and all workmanship shall be of the highest quality developing to fullest the possibilities of the materials and the processes specified.

B. Materials shall be thoroughly stirred and evenly spread without runs, skips, sags, streaks, brush marks, or other defects. Paint shall be cut sharply to lines. Care shall be exercised to avoid lapping of paint over hardware. Painting around glazed openings shall be done promptly after putty is hard, but before shrinkage checks occur and shall seal the jointing of putty to glass.

C. Do not paint over UL or FM labels.

D. Not less than 24 hours between coats shall be allowed for drying, and painting, except as otherwise specified, shall not be allowed to proceed except on thoroughly dry surfaces. All painting application shall be in accordance with manufacturer's published specifications. All doors, cabinets and millwork shall be primed upon delivery to the site with stain or paint as required. All woodworking shall be backprimed before it is installed.

E. Exterior painting shall not be done during or immediately following raining or frosty weather or when the temperature is below 50°F, or likely to drop to freezing during drying. The application of treatments while surfaces are exposed to hot sun, or when temperature is above 90°F, or likely to be, during the drying period, shall be avoided.

A. G.In using paste wood filler on open grain wood, allow sufficient time for "set" then wipe, first across grain, then with the grain, to secure a clean surface.

3.5 PAINTING APPLICATION
A. The following are descriptions of painting applications. The manufacturer's products named below sets standard for products of other manufacturers listed under MATERIALS Paragraphs 1A and B, whose products shall be of equal to those listed below.

B. Seal coats shall be tinted to final color. The first coat applied after the seal coat or primer (or first coat on shop primed surfaces), shall be full color as should be each subsequent coat.

C. All exterior work shall have a minimum of 3 coats (in addition to the specified primer). Provide additional coats as required for proper coverage. Approximately 25% of all painted areas to receive deep tint colors.

D. Where metal to be painted has not already received a shop coat, it shall be cleaned and primed as directed by the Architect.

E. The Architect reserves the right to change color before a coat is applied. Such changes if full coverage can be achieved shall be done by the Contractor without additional cost to the Owner.

END OF SECTION 099113
SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Preparation of surfaces for painting and finishing and for the painting and finishing of all exposed surfaces to receive one of the applications specified in this Section.

B. Puttying set nail heads and repairing other blemishes in wood, gyp board and plaster.

C. Priming and back priming of all wood surfaces.

D. Painting miscellaneous items in walls and ceilings, and any other items not otherwise specified.

E. Painting all visible surfaces of light fixtures, grille work, mechanical and electrical equipment not painted or pre-finished.

F. Painting of all exposed structural steel, miscellaneous steel, roof support and structure, roof deck, ductwork, piping, conduit, insulation, brackets and hangers unless noted otherwise.

G. Painting portion of ductwork interior or other surfaces visible through grilles.

1.2 WORK NOT INCLUDED OR SPECIFIED IN OTHER SECTIONS

A. Shop priming specified in other Sections.

B. Copper, brass, aluminum, stainless steel and other non-ferrous metals shall not be painted unless specifically noted otherwise.

1.3 SYSTEM DESCRIPTION

A. LEED Requirements

1. Painting manufacturer and Contractor shall conform to State and local V.O.C. (Volatile Organic Compound) Regulations in area where Project is located, and requirements of LEED credit EQ-4.1 thru EQ-4.4.

1.4 SUMMARY

A. Qualitative requirements for surface preparation and the application of interior painting with opaque finishes, including painted mechanical and electrical identification, primers, sealers, and finish paints. For the following interior substrates:

1. Concrete.

2. Concrete masonry units (CMU).

3. Steel.


5. Wood.
7. Plaster.
8. Mineral Profile Panel

1.5 SUBMITTALS

A. Before materials are ordered, submit a complete list of proposed materials for each type of product listed. When requested, submit product data and a complete specifications and samples of materials for approval.

B. Samples:

1. Color schedule will be furnished by the Architect prior to commencement of painting work, and from this the painting contractor shall prepare duplicate set of samples of treatments for all major surfaces.

2. Samples shall each be made on material like that to be treated and the material shall be positioned, during execution of the sample, to simulate the job conditions, i.e., vertical, overhead horizontal, or below eye level horizontal.

3. When approved, samples will be so marked, with one set retained by Architect and one by painting contractor. Approved sample shall be strictly duplicated in the work. Additional coats, if required to reproduce approved samples, shall be applied by the Contractor without additional cost to the Owner.

1.6 QUALITY ASSURANCE

A. Codes and Standards: Comply with codes and regulations.

1.7 EXTRA MATERIALS

A. Provide Owner, at completion of job, with five (5) gallons, in one (1) gallon containers, of the primary corridor paint and one (1) of the remaining type and colors of paint selected. Paint to be supplied in full tightly sealed containers labeled with color numbers as listed in the final color schedule.

PART 2 - PRODUCTS

2.1 PAINT, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
B. **VOC Content of Field-Applied Interior Paints and Coatings:** Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:

1. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
2. Nonflat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.
3. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
4. Floor Coatings: VOC not more than 100 g/L.
5. Shellacs, Clear: VOC not more than 730 g/L.
6. Shellacs, Pigmented: VOC not more than 550 g/L.

C. **Colors:** As indicated in a color schedule.

2.2 **MATERIALS**

A. All paint, varnish, enamel, lacquer, and related materials shall be first quality standard products of established manufacturers who have continuous performance in the manufacture of each product for 10 years and approved by the Architect. Provide best quality, first line grade of various types of coatings as regularly manufactured by acceptable paint materials manufacturers. Materials not displaying manufacturer's identification as a standard, best-grade, first line product will not be acceptable. The following manufactures are acceptable:

1. Benjamin-Moore
2. Pratt & Lambert
3. Sherwin-Williams
4. Porter Paint Company (Epoxy)

Other manufactures will be considered, providing performance regarding scrubability and hiding power are equal to or exceed manufactures listed above. Documentation of performance tests by an independent testing laboratory are required before approval.

B. Epoxy coatings shall be manufactured by Porter Paint Company. Epoxy coating colors shall not necessarily be selected from manufacturer's standard colors.

C. Epoxy coating colors shall not necessarily be selected from manufacturer’s standard colors.

D. All materials shall be delivered to the site in unopened original containers, bearing the brand name and the manufacturer's name, and having seals intact. Containers shall not be opened until contents are ready to be used.

E. No materials shall be reduced or changed except as indicated by manufacturer's directions on containers.

F. Thinners and dryers shall be added only in accordance with the manufacturer's printed instructions. Paints with solids shall be mixed at least 24 hours before use and shall be re-mixed before application. Turpentine shall conform to ASTM Standard Specifications D-13.
G. In selecting painting materials, the Contractor shall take into consideration special atmospheric conditions prevailing and any excessive treatment to which the particular surfaces might be subject.

H. All latex paints specified shall be 100% latex base.

2.3 INTERIOR PAINTING SCHEDULE

A. Concrete Surfaces (Semi-Gloss): (Latex)
   1. Primer: Latex Wall Primer, 1.0 - 1.2 mils DFT/coat.
      a. Manufacturers:
         1. Sherwin Williams Co., Preprite 200 latex primer B28W200
         2. Devoe Paint Co., Wonder-Prime Multi-Purpose Acrylic Latex Primer- Sealer, DR51701
         3. Porter Paints Co., #6010 PorterLock WB Acrylic Pigmented Sealer
         4. Coronado Paint Co., #948-11 Superkote 3000 Vinyl Acrylic Primer
   2. Finish Coats: Latex Semi-Gloss Enamel (34-45 units at 60 degrees F.), 2.0 - 2.4 mils DFT/coat.
      a. Manufacturers:
         2. Devoe Paint Co., Wonder-Tones Semi-Gloss Interior Latex Enamel, DR39XX
         4. Coronado Paint Co., #52 Superkote 5000 Acrylic Semi-gloss
   3. Surfaces: Concrete walls and concrete locker bases.

B. Concrete Surfaces (Gloss): (Water Based Epoxy System)
   1. Primer: Latex Wall Primer, 1.0 - 1.2 mils DFT/coat.
      a. Manufacturers:
         1. Sherwin Williams Co., Preprite 200 latex primer B28W200
         2. Devoe Paint Co., Gardcote-WB Epoxy Primer, DP25U935
         3. Porter Paints Co., #9371 DuraGlaze WB Gloss Epoxy
         4. Coronado Paint Co., #948-11 Superkote 3000 Vinyl Acrylic Primer
   2. Finish Coats: Water Based Catalyzed Epoxy (Gloss) (55-75 units at 60 degrees F.), 2.5 - 3.0 mils DFT/coat.
      a. Manufacturers:
         1. Sherwin Williams Co., Water Based Epoxy B70series
         2. Devoe Paint Co., Gardcote-WB Epoxy Gloss Coating, DP25U9XX
         3. Porter Paints Co., #9371 DuraGlaze WB Gloss Epoxy
         4. Coronado Paint Co., #138/250B Acrylic Epoxy Enamel
      a. Manufactures:
         1. ArmorSeal (Sherwin Williams), Tread-Plex Water Based Floor Coating B90 series
         2. Coronado, #52 Tuffshield
         3. Dunn-Edwards, W810 Tuff Floor
   4. Surfaces: Floors scheduled to receive Epoxy Flooring:
      a. Manufacturers:
         1. ArmorSeal (Sherwin Williams), Armor Seal 650 SL/RC Epoxy (2 coats) with Armor Seal 33 Primer
         3. Coronado Paint Co., #138/250B Acrylic Epoxy Enamel
C. Concrete Masonry Surfaces (Semi-Gloss): (Vinyl Acrylic Latex System)
   1. Primer: Vinyl Acrylic Block Filler.
      a. Manufacturers:
         2. Devoe Paint Co., Devoe-Fill Acrylic Latex Block Filler, DV52903
         3. Porter Paints Co., #9203 Quick Fill 900 Interior Exterior Latex Block Filler
         4. Coronado Paint Co., #946-11 Superkote 5000 Latex Block Filler
   2. Finish Coats: Vinyl Acrylic Semi-Gloss Enamel (25-35 units at 60 degrees F.), 1.5 DFT/coat.
      a. Manufacturers:
         2. Devoe Paint Co., Wonder-Speed Semi-Gloss Latex Enamel, DR525XX
         4. Coronado Paint Co., #32 Superkote 5000 Acrylic Semi-Gloss

D. Concrete Masonry Surfaces (Gloss): (Water Based Epoxy - High Humidity)
      a. Manufacturers:
         1. Sherwin Williams Co., Heavy Duty Block Filler B42W46
         2. Devoe Paint Co., Confil HD Waterproofing Masonry Coating, DP88902
         3. PPG Ind. High Performance Coatings, #97-685 AquaPon Polyamide-Epoxy Block Filler
         4. Coronado Paint Co., N/A
   2. Finish Coats: High Solids, Epoxy Polyamine Coating, Gloss (75-95 units at 60 degrees F.) 4.0 - 8.0 mils DFT/coat.
      a. Manufacturers:
         1. Sherwin Williams Co., Water Based Catalyzed Epoxy B70series
         2. Devoe Paint Co., Hi-Glaze II High Solids Epoxy, DP56UXXX
         3. PPG Ind. High Performance Coatings, #98-1 AquaPon WB Epoxy
         4. Coronado Paint Co., N/A
   3. Surfaces: Showers and high humidity areas.

E. Metal - Ferrous (Semi-Gloss): (Alkyd Enamel System, Maximum VOC content 450 grams/liter)
   1. Primer: Modified Alkyd Resin Primer, 3 mils DFT/coat.
      a. Manufacturers:
         1. Sherwin Williams Co., Kem Kromik Universal Primer B50 series
         2. Devoe Paint Co., Mirrolac-WB DTM Flat Primer & Finish, DP8502
         3. Porter Paints Co., #272 PorterGuard Alkyd Metal Primer
         4. Coronado Paint Co., #35-11 Alkyd Metal Primer
   2. Finish Coats: Alkyd Enamel, Semi-Gloss (40-50 units at 60 degrees F.), 3.0 mils DFT/coat.
      a. Manufacturers:
         2. Devoe Paint Co., Mirrolac-Speed Alkyd Semi-Gloss Enamel, DR73XX
         4. Coronado Paint Co., #M13 Polyurethane Semi-gloss Enamel
   3. Surfaces: Hollow metal doors, frames, door mullions, railings, ferrous metal surfaces.

F. Metal - Ferrous (Gloss): (Acrylic-Latex System)
   1. Primer: 100 percent Acrylic, Waterborne, Corrosion Resistant Primer, 3 mils DFT/coat.
      a. Manufacturers:
1. Sherwin Williams Co., DTM Acrylic Primer/Finish B66W1
2. Devoe Paint Co., Mirrolac-WB DTM Flat Primer & Finish, DP8502
3. Porter Paints Co., #215 ProterGuard DTM Acrylic Primer/Finish
4. Coronado Paint Co., #180-11 Acrylic Metal Primer

2. Finish Coats: 100 percent Acrylic, Waterborne, Gloss (60-80 units at 60 degrees F.), 3.0 mils DFT/coat.
   a. Manufacturers:
      1. Sherwin Williams Co., DTM Gloss B66W100
      2. Devoe Paint Co., Mirrolac-WB Gloss Enamel, DP84XX
      3. Porter Paints Co., #2909 PorterGuard DTM Acrylic Gloss Enamel
      4. Coronado Paint Co., #80 Rust Scat Acrylic Gloss

3. Surfaces: Hollow metal doors, frames, doorknobs, railings, ferrous metal surfaces.

G. Metal - Galvanized (Semi-Gloss): (Acrylic Latex System)
   1. Finish Coats: 100 percent Acrylic, Waterborne, Semi-Gloss (30-40 units at 60 degrees F.), 3.0 mils DFT/coat.
      a. Manufacturers:
         1. Sherwin Williams Co., Metalatex Semi-Gloss B42W100
         2. Devoe Paint Co., Mirrolac-WB DTM Flat Primer & Finish, DP8502
         3. Porter Paints Co., #2809 PorterGuard DTM Acrylic Satin Enamel
         4. Coronado Paint Co., #90 Rust Scat Acrylic Semi-Gloss

   2. Surfaces: Hollow metal doors, frames, doorknobs, railings, ferrous metal surfaces.

H. Metal - Galvanized (Gloss): (Acrylic Latex System)
   1. Finish Coats: 100 percent Acrylic, Waterborne, Gloss (60-80 units at 60 degrees F.), 3.0 mils DFT/coat.
      a. Manufacturers:
         1. Sherwin Williams Co., DTM Gloss B66W100
         2. Devoe Paint Co., Mirrolac-WB DTM Flat Primer & Finish, DP8502
            Mirrolac-WB Gloss Enamel, DP84XX
         3. Porter Paints Co., #2909 PorterGuard DTM Acrylic Gloss
         4. Coronado Paint Co., #80 Rust Scat Acrylic Gloss

   2. Surfaces: Hollow metal doors, frames, doorknobs, railings, ferrous metal surfaces.

I. Wood - Painted (Gloss): (Acrylic Latex System)
   1. Primer: Pigmented Interior Modified Alkyd Primer, 2 mils DFT/coat.
      a. Manufacturers:
         2. Devoe Paint Co., Velour Alkyd Enamel Undercoat, DR8801
         3. Porter Paints Co., #1129 Blankit Interior Acrylic Primer
         4. Coronado Paint Co., #37-11 Superkote 5000 Alkyd Primer

   2. Finish Coats: Vinyl Acrylic Gloss Enamel (65-75 units at 60 degrees F.), 2 mils DFT/coat.
      a. Manufacturers:
         1. Sherwin Williams Co., ProClassic Waterborne Acrylic B21series
         2. Devoe Paint Co., Wonder-Speed Semi-Gloss Latex Enamel, DR525XX
         3. Porter Paints Co., #6149 Pro-Master 2000 Latex Gloss Enamel
         4. Coronado Paint Co., #80 Rust Scat Acrylic Gloss

   3. Surfaces: Wood trim, etc.

J. Wood - Painted (Semi-Gloss): (Latex System)
1. Primer: Pigmented Interior Modified Alkyd Primer, 2 mils DFT/coat.
   a. Manufacturers:
      2. Devoe Paint Co., Velour Alkyd Enamel Undercoat, DR8801
      3. Porter Paints Co., #1129 Blankit Interior Acrylic Primer
      4. Coronado Paint Co., #37-11 Superkote 5000 Alkyd Primer

2. Finish Coats: Modified Alkyd Semi-Gloss Enamel (35-45 units at 60 degrees F.), 2.5 - 2.8 mils DFT/coat.
   a. Manufacturers:
      1. Sherwin Williams Co., Pro Classic Waterborne Acrylic B31series
      2. Devoe Paint Co., Wonder-Speed Semi-Gloss Alkyd Enamel, DR509XX
      4. Coronado Paint Co., #90 Rust Scat Acrylic Semi-Gloss

K. Gypsum Board (Flat): (Acrylic Latex System)
   1. Primer: Vinyl Acrylic Latex, 1.1 mils DFT/coat.
      a. Manufacturers:
         1. Sherwin Williams Co., Preprite 200 Primer B28W200
         2. Devoe Paint Co., Wonder-Tones Vinyl Latex Primer-Sealer, DR50801
         3. Porter Paints Co., #567 Max Prime Latex Drywall Primer
         4. Coronado Paint Co., #948-11 Superkote 3000 Vinyl Acrylic Primer
   2. Finish Coats: Vinyl Acrylic Flat (0-5 units at 90 degrees F.), 1.4 mils DFT/coat.
      a. Manufacturers:
         2. Devoe Paint Co., Wonder-Speed Flat Latex Wall Paint, DR506XX
         3. Porter Paints Co., #9585 Ceiling White-Flat
         4. Coronado Paint Co., #28 Superkote Vinyl Acrylic Flat
   3. Surfaces: Ceilings, bulkheads

L. Gypsum Board (Eg-Shel): (Modified Alkyd System - Low V.O.C.)
   1. Primer: Vinyl Acrylic Latex, 1.1 mils DFT/coat.
      a. Manufacturers:
         1. Sherwin Williams Co., Preprite 200 Primer B28W200
         2. Devoe Paint Co., Wonder-Prime Multi-Purpose Acrylic Latex Primer-Sealer, DR51701
         3. Porter Paints Co., #867 Pro-master 2000 Latex Primer
         4. Coronado Paint Co., #948-11 Superkote 3000 vinyl Acrylic Primer
   2. Finish Coats: Modified Alkyd Eg-Shel (20-30 units at 60 degrees F.), 2.5 - 2.8 mils DFT/coat.
      a. Manufacturers:
         1. Sherwin Williams Co., ProMar 200 Low VOC Alkyd B34WZ250
         2. Devoe Paint Co., Mirrolac-Speed Alkyd Eggshell Enamel, DR72XX
         3. Porter Paints Co., #129 Pro-Master 2000 Alkyd Satin
         4. Coronado Paint Co., #25 Superkote 5000 Alkyd Eggshell
   3. Surfaces: Gypsum board surfaces, subject to moderate abuse

M. Gypsum Board (Semi-Gloss): (Water Based Epoxy System)
   1. Primer: Vinyl Acrylic Latex, 1.1 mils DFT/coat.
      a. Manufacturers:
         1. Sherwin Williams Co., Preprite 200 Primer B28W200
2. Devoe Paint Co., Wonder-Prime Multi-Purpose Acrylic Latex Primer-Sealer, DR51701
3. Porter Paints Co., #867 Pro-master 2000 Latex Primer
4. Coronado Paint Co., #948-11 Superkote 3000 Vinyl Acrylic Primer

2. Finish Coats: Water Based Catalyzed Epoxy, Semi-Gloss (20-30 units at 60 degrees F.), 2.5 - 3.0 mils DFT/coat.
   a. Manufacturers:
      1. Sherwin Williams Co., Water Based Epoxy B70series
      2. Devoe Paint Co., Gardcote-WB semi-Expoxy Gloss Coatin, DP25U8XX
      3. Porter Paints Co., #9321 DuraGlaze WB Epoxy-Semi-Gloss


N. Plaster Surfaces (Eg-Shel): (Acrylic Latex System)
   1. Primer: Interior Modified Alkyd Primer, 2 mils DFT/coat.
      a. Manufacturers:
         2. Devoe Paint Co., Wonder-Prime Multi-Purpose Acrylic Latex Primer-Sealer DR51701
         3. Porter Paints Co., #184 Sta-Kil WB Acrylic Primer
         4. Coronado Paint Co., #37-11 Superkote 5000 Alkyd Primer
   2. Finish Coats: Vinyl Acrylic Eg-Shel Enam el (10-20 units at 85 degrees F.), 1.5 mils DFT/coat.
      a. Manufacturers:
         1. Sherwin Williams Co., ProMar 200 Latex Eg-Shel B20W200
         2. Devoe Paint Co., Wonder-Speed Eggshell Latex Enamel, DR526XX
         3. Porter Paints Co., #6129 Pro-Master 2000 Latex Eggshell
         4. Coronado Paint Co., #30 Superkote Acrylic Eggshell Enamel

O. Exposed Structure - Ferrous (Flat): (Waterborne)
   1. Primer
      a. Manufacturers:
         1. Sherwin Williams Co., DTM Primer/Finish B66series
         2. Devoe Paint Co., Mirrolac-WB DTM Flat Primer & Finish, DP8502
         3. Porter Paints Co., #212 PorterGuard DTM Acrylic Primer/Finish
         4. Coronado Paint Co., #35-11 Alkyd Metal Primer
   2. Finish Coats: Acrylic Waterborne (white) flat (0-10 units at 60 degrees F.), 1 mil DFT/coat.
      a. Manufacturers:
         1. Sherwin Williams Co., Waterborne Acrylic Dryfall B42series
         2. Devoe Paint Co., Mirrolac-WB DTM Flat Primer & Finish DO8502 (white)
         3. Porter Paints Co., #9620 Porterguard WB Spray Dry Fog Flat Latex
         4. Coronado Paint Co., #28 Superkote Vinyl Acrylic Flat

P. Exposed Structure - Galvanized (Flat): (Waterborne)
   1. Finish Coats: Acrylic Waterborne (white) flat (0-10 units at 60 degrees F.), 1 mil DFT/coat.
      a. Manufacturers:
         1. Sherwin Williams Co., Waterborne Acrylic Flat B42series
         2. Devoe Paint Co., Mirrolac-WB DTM Flat Primer & Finish, DP8502
         3. Porter Paints Co., #9620 Porterguard WB Spray Dry Fog Flat Latex
         4. Coronado Paint Co., #10 Crylicote Acrylic Flat

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
3. Wood: 15 percent.
4. Gypsum Board: 12 percent.
5. Plaster: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Before commencing work on surfaces of any type, the Painting Contractor shall carefully inspect same and satisfy himself that they are dry and in all other respects suitable to receive the specified treatment. If the condition of any surface is such that it cannot be put in proper condition by normal preparatory methods, and arrangements for prompt correction cannot be made at once with the General Contractor, the Painting Contractor shall not undertake surface preparation and shall, instead, at once address a written request to the General Contractor for corrections which will provide an acceptable surface.

E. Application of any coating to a surface will constitute acceptance of the surface by the Painting Contractor. If after treatment, the completed finish (or any portion thereof) blisters, checks, peel, or otherwise shows indication of dampness or other irregular condition of surface, the Painting Contractor shall, at his own expense, remove the applied treatment and refinish the part affected to the satisfaction of the Architect. (The Painting Contractor should determine dryness of all moisture-holding materials by use of a reliable electronic moisture meter.

F. Each coat of material applied must be inspected and approved by the Architect before the application of the succeeding specified coat; otherwise, no credit for the concealed coat will be given and the Painting Contractor shall assume the responsibility to recoat the work in question. The Painting Contractor shall notify the Architect, when each coat is completed, for inspection.

3.2 USE OF PREMISES

A. No plumbing fixture, open waste, drain, or vent pipe (or other pipe of any kind), shall be used to dispose of paint materials, used rags, waste, or other materials.

B. Water closets, tubs, other fixtures of all kinds, shall not be used as supports for planking and shall be thoroughly protected from damage at all times.
C. Provide, erect and maintain all staging and scaffolding required for execution of the work, move when necessary at the option of the Architect, to permit installation of other work. Remove from premises promptly at completion of work.

3.3 PREPARATION AND APPLICATION

A. For renovation projects, consult "MPI Maintenance Repainting Manual" and revise first paragraph below and paint systems specified in the Interior Painting Schedule.

B. Before painting is started in an area, finish carpentry, including correction and adjustments shall have been completed, all glazing installed and the area of the building cleaned of all debris, thoroughly broom cleaned and dusted out. All plastering and drywall shall be finished and shall be thoroughly dry.

C. Finish hardware and plates for electric outlets that have been fitted by the General and Electrical Contractors, shall be removed by and replaced by the Painting Contractor.

D. Nail holes in all exposed woodwork shall be filled with putty colored to match accurately the approved finishes. Seal knots and pitch streaks before applying primer. Shellac on interior, spar varnish on exterior.

E. Sandpapering of all wood joints and exposed wood surfaces shall follow paint priming or wood stain application on natural finish work and shall precede second coat work. Sand only with the grain.

F. Metal surfaces shall be smooth and thoroughly cleaned of grease, rust, scale and dust. Shop coats that are marred or abraded shall be cleaned and touched up with primer matching the shop coat.

G. When part will be exposed to view, sandpaper the entire treated area smooth, feather the edge of surrounding undamaged prime coat, and extend spot priming onto same, in a manner to eliminate evidence of repair.

H. Before painting any metal, the surfaces shall be gone over carefully with body putty, if necessary, and sanded smooth.

I. Unless the prime coat material to be used is recommended by its manufacturer for application over zinc-coated surfaces of the type at hand, after cleaning and any necessary de-glossing, only, surfaces must be given phosphate pre-treatment prior to application of prime coat; usual "vinegar etch" or acid pre-treatment (wash) will not be permitted.

J. Phosphate Pre-Treatment: Crystalline zinc phosphate type; either "Lithoform", made by the American Chemical Paint Co., Ambler, Pa., or Galvaprep No. 5", made by Neilson Chemical Co., Detroit, Michigan as approved. Follow manufacturer's instructions and directions exactly, as to cleaning prior to treatment, application of treatment and after-rinse.

K. Concrete Block Masonry:
1. Prepare concrete block masonry surfaces by removing all efflorescence, dirt, rust, oil and
grease stains, and method used shall be as determined by the Painting Contractor and
paint manufacturer's representative. Surface must be acceptable before painting.

2. Before first paint coat is applied, spot prime any nails and other exposed metal occurring in
the surfaces with an oil base masonry primer as recommended by the paint manufacturer, to
insure against rust.

L. Plaster and drywall surfaces shall be sand-papered smooth, and scratches, cracks and abrasions
shall be satisfactorily eliminated before priming. Spot seal "hot spots" after first coat has dried.

M. Storage for paint materials, preparation and mixing shall be in well-lighted and ventilated
central location; but shall not be allowed on finished floor. Oily rags and waste must be
removed from building every night, and must not be allowed to accumulate.

N. Dropcloths shall be generously used and shall be carefully placed and secured over floor areas
as the paint work progresses.

O. Adequate safeguards shall be provided against damage from the escape of materials during
spray operation. Except that stains may be applied by cloth or sponge, all coatings shall be
applied by brush or roller unless spray application is specifically named as acceptable, in
description of required treatment.

P. All adjoining surfaces, finish floors and fixtures shall be carefully protected throughout the
painting operations against spray or splash stains, marks or other damage; and should such
defacement occur as a result of the work, it shall be corrected in a manner acceptable and
satisfactory to the Architect and without added cost to the Owner.

Q. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and
incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers as required to
produce paint systems indicated.

R. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks,
roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color
breaks.

S. Painting Mechanical and Electrical Work: Paint items exposed in equipment rooms and
occupied spaces including, but not limited to, the following:

1. Mechanical Work:
   a. Uninsulated metal piping.
   b. Pipe hangers and supports.
   c. Tanks that do not have factory-applied final finishes.
   d. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets
      and outlets.
   e. Duct, equipment, and pipe insulation having cotton or canvas insulation covering
      or other paintable jacket material.
   f. Mechanical equipment that is indicated to have a factory-primed finish for field
      painting.

2. Electrical Work:
a. Electrical equipment that is indicated to have a factory-primed finish for field painting.

T. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

U. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.4 WORKMANSHIP

A. All painting shall be done by skilled mechanics working under the supervision of a capable foreman and all workmanship shall be of the highest quality developing to fullest the possibilities of the materials and the processes specified.

B. Materials shall be thoroughly stirred and evenly spread without runs, skips, sags, streaks, brush marks, or other defects. Paint shall be cut sharply to lines. Care shall be exercised to avoid lapping of paint over hardware. Painting around glazed openings shall be done promptly after putty is hard, but before shrinkage checks occur and shall seal the jointing of putty to glass.

C. Tops and bottoms of all wood doors shall have at least 3-finish coats. Do not paint over UL or FM labels.

D. Not less than 24 hours between coats shall be allowed for drying, and painting, except as otherwise specified, shall not be allowed to proceed except on thoroughly dry surfaces. All painting application shall be in accordance with manufacturer's published specifications. All doors, cabinets and millwork shall be primed upon delivery to the site with stain or paint as required. All wood working shall be backprimed before it is installed.

E. Interior work shall be done only when the building has been thoroughly dried out, by natural or artificial heat, and when the work area is properly heated and ventilated, clean and as nearly dust-free as possible. Apply interior finishes only when a room temperature of at least 60°F can be maintained during application of treatments and until coatings are dry (for application of stains and similar treatments, a temperature of at least 75°F).

3.5 PAINTING APPLICATION

A. The following are descriptions of painting applications. The manufacturer's products named below sets standard for products of other manufacturers listed under MATERIALS Paragraphs 1A and B, whose products shall be of equal to those listed below.

B. Seal coats shall be tinted to final color. The first coat applied after the seal coat or primer (or first coat on shop primed surfaces), shall be full color as should be each subsequent coat.

C. All exterior work shall have a minimum of 3 coats. All interior work shall have a minimum of 2 finish coats (in addition to the specified primer). Provide additional coats as required for proper coverage. Approximately 25% of all painted areas to receive deep tint colors.
D. Where metal to be painted has not already received a shop coat, it shall be cleaned and primed as directed by the Architect.

E. The Architect reserves the right to change color before a coat is applied. Such changes if full coverage can be achieved, shall be done by the Contractor, without additional cost to the Owner.

END OF SECTION 099123
SECTION 10111 - VISUAL DISPLAY SURFACES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Markerboards.
B. Tackboards.

1.3 RELATED SECTIONS

A. Section 06100 – Rough Carpentry: For blocking for visual display surfaces.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Show location of tack assembly seams and joints.
   2. Include sections of typical trim members.
C. Samples for Initial Selection: For each type of product indicated as follows:
   1. Cork Swatches: Manufacturer’s full range of cork colors for initial color selection.
   2. Tack Assembly: Not less than 8-1/2 by 11 inches (215 by 280 mm), mounted on substrate indicated for final Work. Include one panel for each type, color, and texture required.
   3. Trim: 6-inch- (152-mm-) long sections of each trim profile including corner section.
D. Samples for Verification: For each type of visual display surface indicated and as follows:
   1. Visual Display Surface: Not less than 8-1/2 by 11 inches (215 by 280 mm), mounted on substrate indicated for final Work. Include one panel for each type, color, and texture required.
E. Warranties: Sample of special warranties.
F. Maintenance Data: For visual display surfaces to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of visual display surface through one source from a single manufacturer.
B. Product Options: Drawings indicate size, profiles, and dimensional requirements of visual display surfaces and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

C. Fire-Test-Response Characteristics: Provide fabrics with the surface-burning characteristics indicated, as determined by testing identical products per ASTM E84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

D. Forest Certification: Provide components made with not less than 50 percent of wood products obtained from forests certified by an FSC-accredited certification body.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver factory-built visual display boards completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to Architect. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site.

B. Store visual display units vertically with packing materials between each unit.

1.7 WARRANTY

A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer's standard form in which manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Surfaces lose original writing and erasing qualities.
      b. Surfaces exhibit crazing, cracking, or flaking.
   2. Warranty Period: 50 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Basis-of-Design Product: The design for each visual display surface is based on the product specified. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 MATERIALS, GENERAL

A. Recycled Content: Use materials and products that contain the maximum amount of recycled content allowed that retains material integrity.
B. Local/Regional Materials: Give preference to manufacturer’s whose facilities are within a 500 mile radius of the project site. Also give preference to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

C. Certified Wood: Use wood based products made from wood obtained from forests certified by an FSC accredited certification body to comply with the Forest Stewardship Councils “Principles and Criteria.”

D. VOC Content: Adhesives, sealants, paints, welding, and coatings applied on-site on the interior of the building and products used on the interior of the building shall comply with VOC limits as specified in Section 018113 - Sustainable Design Requirements.
   1. Use materials that have the minimum VOC content in units of g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Composite Wood and Agrifiber: Use only composite wood and agrifiber products free of urea formaldehyde resin binders.

2.3 MATERIALS

A. Porcelain-Enamel Face Magnetic Sheet: Porcelain-enamel-clad, ASTM A463/A463M, Type 1, stretcher-leveled aluminized steel, with 0.0236-inch (0.60-mm) uncoated thickness; with porcelain-enamel coating fused to steel at approximately 1000 deg F (538 deg C).
   1. Gloss Finish: Low gloss; dry-erase markers wipe clean with dry cloth or standard eraser. Suitable for use as projection screen.

B. Hardboard: AHA A135.4, tempered.

C. Particleboard: ANSI A208.1, Grade 1-M-1, made with binder containing no urea formaldehyde.

D. Fiberboard: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde.

E. Cork Sheet: MS MIL-C-15116-C, Type II.

F. Natural Cork Sheet: Seamless, single-layer, compressed fine-grain cork sheet; bulletin board quality; face sanded for natural finish.


H. Aluminum Tubing: ASTM B429, Alloy 6063.

I. Fasteners: Provide screws, bolts, and other fastening devices made from same material as items being fastened, except provide hot-dip galvanized, stainless-steel, or aluminum fasteners for exterior applications. Provide types, sizes, and lengths to suit installation conditions. Use security fasteners where exposed to view.
2.4 MARKERBOARD ASSEMBLIES

A. Porcelain-Enamel Magnetic Markerboard Assembly: Balanced, high-pressure, factory-laminated markerboard assembly of 3-ply construction consisting of backing sheet, core magnetic material, and porcelain-enamel face sheet with low-gloss finish.
   1. Available Manufacturers:
      a. Best-Rite Manufacturing.
      b. Claridge Products & Equipment, Inc.
      c. Egan Visual Inc.
      d. Ghent Manufacturing Inc.
   2. Manufacturer's Standard Core: Minimum 1/4 inch (6 mm) thick, with manufacturer's standard moisture-barrier backing, magnetic.
   3. Laminating Adhesive: Manufacturer's standard moisture-resistant thermoplastic type.

B. Markerboard Sheet Assembly: Fabricated from 0.0209-inch- (0.55-mm-) thick, porcelain-enamel face sheets for direct application to wall surface.

2.5 MARKERBOARD ACCESSORIES

A. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch- (1.57-mm-) thick, extruded aluminum; of size and shape indicated.

B. Chalktray: Manufacturer's standard, continuous.
   1. Box Type: Extruded aluminum with slanted front, grooved tray, and cast-aluminum end closures.

C. Marking Implements: Provide two new boxes of approved markers and one new eraser for each markerboard.

2.6 TACKBOARD ASSEMBLIES

A. Basis-of-Design Product: The design for the bulletin boards is based on the manufacturer identified below. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
   3. ADP/Lemco, Inc.
   5. Marsh Industries, Inc.

B. Natural-Cork Tack Assembly: 1/4-inch- (6-mm-) thick, natural cork sheet with burlap backing factory laminated to 1/4-inch- (6-mm-) thick hardboard backing.
2.7 FABRICATION

A. Porcelain-Enamel Visual Display Assemblies: Laminate porcelain-enamel face sheet and backing sheet to core material under heat and pressure with manufacturer's standard flexible, waterproof adhesive.

B. Fabricate tack boards to requirements indicated for dimensions, design, and thickness and finish of materials.

C. Use metals and shapes of thickness and reinforcing to produce flat surfaces, free of oil canning, and to impart strength for size, design, and application indicated.

D. Aluminum Frames and Trim: Fabricate units straight and of single lengths, keeping joints to a minimum. Miter corners to neat, hairline closure.

2.8 ALUMINUM FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

E. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance.

B. Examine roughing-in for electrical power systems to verify actual locations of connections before installation of motor-operated, sliding visual display units.

C. Examine walls and partitions for proper backing for visual display surfaces.
D. Examine walls and partitions for suitable framing depth where sliding visual display and recessed units will be installed.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove dirt, scaling paint, projections, and depressions that will affect smooth, finished surfaces of visual display boards.

B. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, and substances that will impair bond between visual display boards and surfaces.
   1. Seal wall surfaces indicated to receive visual display fabric.

C. Prepare recesses for sliding visual display units as required by type and size of unit.

3.3 INSTALLATION, GENERAL

A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
   1. Mounting Height: 36 inches (914 mm) above finished floor to top of chalktray.
   2. Where size of visual display boards or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by Architect from manufacturer's standard structural support accessories to suit conditions indicated.

3.4 INSTALLATION OF FACTORY-FABRICATED VISUAL DISPLAY UNITS

A. Visual Display Boards: Attach visual display boards to wall surfaces with egg-size adhesive gobs at 16 inches (400 mm) oc horizontally and vertically.
   1. Attach chalktrays to boards with fasteners at not more than 12 inches (300 mm) oc.

B. Tack Boards: Attach units to wall surface with concealed wood cleats screwed to wall.

3.5 CLEANING AND PROTECTION

A. Construction Waste Management: Manage construction waste in accordance with provisions of Division 1 Section 'Construction Waste Management'. Submit documentation for Credit MR 2.1 and Credit MR 2.2 to satisfy the requirements of that Section.

B. Clean visual display surfaces according to manufacturer's written instructions. Attach one cleaning label to visual display surface in each room.

C. Adjust doors to operate smoothly without warp or bind and contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

D. Touch up factory-applied finishes to restore damaged or soiled areas.
E. Cover and protect visual display surfaces after installation and cleaning.

END OF SECTION 10111
SECTION 102113 - TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Solid-polymer toilet compartments configured as toilet enclosures and urinal screens.

B. Related Sections:
   1. Section 018113 – Sustainability requirements

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content.

C. Shop Drawings: For toilet compartments. Include plans, elevations, sections, details, and attachments to other work.

D. Samples for each exposed product and for each color and texture specified.

E. Maintenance data.

1.3 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84, or another standard acceptable to authorities having jurisdiction, by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 75 or less.
   2. Smoke-Developed Index: 450 or less.

B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" and ICC/ANSI A117.1 for toilet compartments designated as accessible.
PART 2 - PRODUCTS

2.1 SOLID-POLYMER UNITS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Bradley Corporation: Bradmar-Series 400 - Sentinel or comparable product by one of the following:
   1. Scranton Products, Hiny Hiders.
   2. Bobrick, Sierra Series.

B. Toilet-Enclosure Style: Overhead braced, Floor anchored.

C. Urinal-Screen Style: Wall hung, with full height bracket secured to wall.

D. Door, Panel, and Pilaster Construction: Solid, high-density polyethylene (HDPE) or polypropylene (PP) panel material, not less than 1 inch (25 mm) thick, seamless, with eased edges, and with homogenous color and pattern throughout thickness of material.
   1. Integral Hinges: Configure doors and pilasters to receive integral hinges.
   2. Heat-Sink Strip: Manufacturer's standard continuous, stainless-steel strip fastened to exposed bottom edges of solid-polymer components to prevent burning.
   3. Polymer Panel Finish: Two colors and patterns in each room.
      a. Color and Pattern: As selected by Architect from manufacturer's full range.

E. Pilaster Shoes and Sleeves (Caps): Manufacturer's standard design; stainless steel.

F. Brackets (Fittings):
   1. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel.

2.2 ACCESSORIES

A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.
   2. Hinges: Manufacturer's standard continuous, cam type that swings to a closed or partially open position.
   3. Latch and Keeper: Manufacturer's standard surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
   4. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories.
   5. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
   6. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.
   7. Provide 1 extra set of all hardware / accessories for attic stock. Turn over to Owner.
B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.

C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel.

2.3 FABRICATION

A. Overhead-Braced, Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism. Provide manufacturer’s standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.

B. Floor Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment at bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.

C. Door Size and Swings: Unless otherwise indicated, provide 24-inch- (610-mm-) wide, in-swinging doors for standard toilet compartments and 36-inch- (914-mm-) wide, out-swinging doors with a minimum 32-inch- (813-mm-) wide, clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

B. Clearances: Maximum 1/2 inch (13 mm) between pilasters and panels; 1 inch (25 mm) between panels and walls.

3.2 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 102113
SECTION 102600 - WALL AND CORNER GUARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections:
   1. Section 018113 – Sustainability Requirements

1.2 SECTION INCLUDES

A. Bumper/crash rails.

B. Corner guards.

1.3 PERFORMANCE CHARACTERISTICS.

A. Provide components identical to those tested in accordance with ASTM E84 for fire performance characteristics indicated. Identify components with appropriate markings from the testing organization.
   1. Flame Spread: 25 or less.
   2. Smoke Developed: 450 or less.
   3. Impact Strength: Provide components with minimum impact resistance of 25.4 ft. lbs per sq. ft. when tested in accordance with ASTM D256 (Izod impact, ft. lbs per inch notch).

1.4 SUBMITTALS

A. Product Data: Provide manufacturers written data for bumpers and corner guards.

B. Shop Drawings: Submit drawings indicating method of attachment, backing required, and fasteners.

C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
   1. Bumper Rails and Corner Guards: 12 inches (300 mm) long. Include examples of joinery, corners, end caps, and field splices.
   2. Kick Plates: 6 by 6 inches (150 by 150 mm) square.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store impact-resistant wall-protection units in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
   1. Maintain room temperature within storage area at not less than 70 deg F (21 deg C) during the period plastic materials are stored.
2. Keep plastic sheet material out of direct sunlight.
3. Store plastic wall-protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F (21 deg C).
   a. Store corner-guard covers in a vertical position.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install impact-resistant wall-protection units until building is enclosed and weatherproof, wet work is complete and dry, and HVAC system is operating and maintaining temperature at 70 deg F (21 deg C) for not less than 72 hours before beginning installation and for the remainder of the construction period.

B. Field Measurements: Verify actual locations of walls, columns, and other construction contiguous with impact-resistant wall-protection units by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Acrovyn – basis of design
   2. Construction Specialties, Inc.
   3. InPro

2.2 MATERIALS, GENERAL

A. Recycled Content: Use materials and products that contain the maximum amount of recycled content allowed that retains material integrity.

B. Local/Regional Materials: Give preference to manufacturer’s whose facilities are within a 500 mile radius of the project site. Also give preference to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

2.3 MATERIALS

A. Plastic Material: Extruded, rigid, textured, chemical- and stain- resistant, polyvinyl chloride (PVC) or acrylic modified vinyl plastic. Comply with ASTM D256 for impact resistance and ASTM E84 for flame spread and smoke developed characteristics.

B. Colors and Textures of Plastic Material: Provide material that matches selections made from the manufacturer's full range of standard colors and textures.

C. Aluminum Extrusions: Alloy and temper recommended for use and finish indicated, but with not less than strength and durability properties in ASTM B221 for 6063-T5.
D. Fasteners: Aluminum, nonmagnetic stainless steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with components, hardware, anchors, and other items being fastened. Use theft-proof fasteners where exposed to view.

2.4 BUMPER/CRASH RAILS

A. Bumper Rail: Assembly consisting of continuous snap-on plastic cover installed over continuous retainer; designed to spring back when hit.
   1. Cover: Rigid, impact-resistant plastic, minimum 0.08 inch thick, 1/4 inch radius.
   2. Retainer: Continuous one-piece extruded aluminum retainer, minimum 0.07 inch thick.
   3. Equal to Acroyn SCR-48N

2.5 CORNER GUARDS

A. Surface-Mounted, Resilient, Plastic Corner Guards: Assembly consisting of snap-on PVC cover installed over continuous aluminum retainer; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition.
   1. Cover: PVC, minimum 0.078-inch (2.0-mm) wall thickness; in dimensions and profiles indicated on Drawings.
      a. Profile: Nominal 3-inch- (75-mm-) long leg and 1/4-inch (6-mm).
      b. Height: 8 feet (2.4 m).
      c. Color and Texture: As selected by Architect from manufacturer's full range.
   2. Retainer: Minimum 0.060-inch- (1.5-mm-) thick, 1-piece, extruded aluminum.
   3. Top and Bottom Caps: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.
   4. Equal to Acroyn SM series

2.6 ACCESSORIES

A. End Caps: Prefabricated, injection-molded end caps and corners with concealed splices, cushions, and mounting hardware. (End caps and corners shall match cover color and be field adjustable for close alignment with snap-on covers.)

B. Brackets, Flanges, Fittings, and Anchors: Provide for interconnection of members to other construction.

C. Adhesive: Type recommended by manufacturer for use with material being adhered to substrate indicated.
   1. Use adhesives and sealants that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
      a. Gypsum Board and Panel Adhesives: 50 g/L.
      b. Multipurpose Construction Adhesives: 70 g/L.
      c. Contact Adhesive: 80 g/L.

2.7 FABRICATION

A. Preassemble components in the shop to the greatest extent possible. Disassemble only as necessary for shipping and handling.
B. Fabricate with tight seams and joints, with exposed edges rolled. Provide surfaces free of wrinkling, chipping, uneven coloration, dents, or other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions in which components will be installed.
B. Complete finishing operations, including painting, before beginning installation.
C. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prior to installation clean substrates to remove dust, debris, and loose particles.

3.3 INSTALLATION

A. Install plumb, level, and true to line without distortion. Do not use material with chips, cracks, voids, stains, or other defects that might be visible in the finished work.
B. Install aluminum retainers, mounting brackets, and other accessories in accordance with the manufacturer's instructions. Where splices occur in horizontal runs of over 20 feet, splice aluminum retainers and plastic covers at different locations along the run.

3.4 CLEANING

A. Upon completion, clean plastic covers and accessories using standard ammonia-based household cleaning agent. Clean metal components in accordance with the manufacturer's recommendations.
B. Remove surplus materials, rubbish, and debris resulting from installation upon completion of work and leave installation in neat, clean condition.

END OF SECTION 10260
SECTION 10 28 00 - TOILET ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Public-use washroom accessories.
   2. Custodial accessories.

B. Owner-Furnished Material:
   1. Toilet Tissue Dispenser.

C. Related Sections
   1. Sections 018113 – Sustainability Requirements

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content.
   2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regionally manufactured and regionally extracted and manufactured materials. Include statement indicating cost for each regionally manufactured material.
      a. Include statement indicating location of manufacturer and distance to Project for each regionally manufactured material.
      b. Include statement indicating location of manufacturer and point of extraction, harvest, or recovery for each raw material used in regionally extracted and manufactured materials. Indicate distance to Project and fraction by weight of each regionally manufactured material that is regionally extracted.

C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
   1. Identify locations using room designations indicated.
   2. Identify products using designations indicated.
1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.4 WARRANTY

A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PUBLIC-USE WASHROOM ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. A & J Washroom Accessories, Inc.
2. American Specialties, Inc.
5. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.
6. Tubular Specialties Manufacturing, Inc.

B. Toilet Tissue (Roll) Dispenser:

1. Provided by Owner, Installed by Contractor.

C. Paper Towel (Folded) Dispenser / Waste Receptacle:

2. Description: Satin-finish stainless steel with flush tumbler lock.
3. Size: 16” wide x 54 ¾” high, 4” deep.

D. Wall Mounted Waste Receptacle

1. Basis of Design Product: Bobrick Model B-43644
2. Satin finish with liner mate
3. Size – 12.8 gallon

E. Liquid-Soap Dispenser:


3. Size: 7” wide x 6 1/8” high.

Grab Bar:
5. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
   a. Finish: Smooth, No. 4 finish (satin) on ends and slip-resistant texture in grip area.
7. Configuration and Length: As indicated on Drawings.

F. Sanitary-Napkin Disposal Unit

2. Description: Satin-finish stainless steel, recessed.
3. Size: 12 ¾” wide x 11” high x 4” recessed depth.

G. Mirror Unit
1. Frame: Stainless-steel angle, 0.05 inch (1.3 mm) thick.
   a. Corners: Manufacturer's standard
2. Integral Shelf: 5 inches (127 mm) deep.
   a. One-piece, galvanized-steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
   b. Wall bracket of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.

H. Hand Dryers
1. Electric Operated Hand Dryers
2. Basis of Design Bobrick Recessed Automatic Hand Dryer B-3725
3. Approved alternate manufacturers
   a. Bobrick
   b. AJ Washroom
   c. Shall be high velocity type dryer

2.2 SHOWER ROOM ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. A & J Washroom Accessories, Inc.
2. American Specialties, Inc.
5. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.
6. Tubular Specialties Manufacturing, Inc.

C. Shower Curtain Rod:

2. Description: 1-inch (25.4-mm) OD; fabricated from nominal 0.0375-inch- (0.95-mm-) thick stainless steel.
4. Finish: No. 4 (satin).

D. Shower Curtain:

1. Basis-of-Design Product: Bobrick Model Nos. 204-1 (hooks), 204-2 (shower curtain)
2. Size: Minimum 12 inches (305 mm) wider than opening by 72 inches (1828 mm) high.
3. Material: Vinyl, minimum 0.008 inch (0.2 mm) thick, opaque, matte
5. Grommets: Corrosion resistant at minimum 6 inches (152 mm) o.c. through top hem.
6. Shower Curtain Hooks: Chrome-plated or stainless-steel, spring wire curtain hooks with snap fasteners, sized to accommodate specified curtain rod. Provide one hook per curtain grommet.

E. Soap Dish:

2. Description: Without washcloth bar.

F. Robe Hook:

2. Description: Single-prong unit.

2.3 CUSTODIAL ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. A & J Washroom Accessories, Inc.
2. American Specialties, Inc.
5. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.
6. Tubular Specialties Manufacturing, Inc.

B. Mop and Broom Holder:

2. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
3. Length: 34 inches.
5. Mop/Broom Holders: Three, spring-loaded, rubber hat, cam type.
   a. Shelf: Not less than nominal 0.05-inch- (1.3-mm-) thick stainless steel.
   b. Rod: Approximately 1/4-inch- (6-mm-) diameter stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

B. Grab Bars: Install to withstand a downward load of at least 250 lbf (1112 N), when tested according to ASTM F 446.

END OF SECTION 10 28 00
SECTION 103050 – MANUFACTURED GLASS FIREPLACES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials and equipment required for complete installation of the equipment and furnishing items, as shown on the Drawings and as specified herein.

B. Related Sections:
   1. Section 018113 - Sustainability Requirements

1.2 SUBMITTALS

A. Provide shop drawings, as required for the items specified, for Architect’s approval, indicating all materials, details of assembly, installation for specific job conditions and workmanship.

1.3 DELIVERY AND STORAGE

A. All materials shall be delivered to the Project in manufacturer's original unopened containers, clearly marked as to manufacturer and material contents. All materials shall be stored off the ground in a protected, dry area.

1.4 REFERENCES

A. ANSI Z223.1 – National Fuel Gas Code

1.5 QUALITY ASSURANCE

A. Licensed as required by local codes
B. National Fireplace Institute certified installer and Factory trained installed from manufacturer

PART 2 - PRODUCTS

2.1 GAS FIREPLACE

A. Direct Vent Type Natural Gas Fireplace, Single Sided
B. Basis of Design/Approved Manufacturers
   Majestic – Echel72in
   Approved alternate Manufacturers
   a. Napoleon – Architect to review prior to bid
   b. Heatilator – Architect to review prior to bid
C. Natural Gas, 40,000 BTU maximum, 20,500 BTU Minimum, 75% efficiency
E. Direct Vent
F. Coordination of final dimensions with fireplace surround is required.
G. Vent and Flue – manufacturer’s standard hard piped configuration to go out the side wall of the building through the chase provided. Provide standard wall cap at exterior. Support vent and flue as required and recommended by manufacturer.

H. Accessories and Finishes
   a. Log Set and glowing embers
   b. Standard Log Fire Grate
   c. Echelon II Picture Frame Front
   d. Interior Panels Standard Brick finish
   e. Standard Safety Screen
   f. Remote Control Operator
   g. Include blower unit for each room face.

I. Provide fireplace housing, interior panels, burner, venting, controls, and accessories required for a complete installation. Include any required framing kits (non-combustible) to support fireplace and all required safety mechanisms.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install in complete accordance with manufacturer's recommendation.
   B. Confirm that site and conditions have been properly prepared prior to installation.

3.2 PREPARATION
   A. Clean Surfaces completely
   B. Prepare opening and supporting surfaces to comply with local codes and manufacturer’s recommendations to maintain approved construction rated classification.
   C. Verify proper power supply and fuel sources are available.

3.3 INSTALLATION
   A. Install in accordance with manufacturer’s instructions, and the requirements of authorities having jurisdiction.
   B. Use manufacturer’s fireplace and venting guidelines for vent sizes, clearances, and other requirements.
   C. Upon completion of installation, inspect all exposed surfaces and touch up as required.
   D. Test for Proper operation and complete warranty card.

END OF SECTION 103050
SECTION 10 44 13 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes fire-protection cabinets for portable fire extinguishers.

B. Related Sections:
   1. Section 018113 – Sustainability requirements

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fire-protection cabinets.

C. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content.
   2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regionally manufactured and regionally extracted and manufactured materials. Include statement indicating cost for each regionally manufactured material.
      a. Include statement indicating location of manufacturer and distance to Project for each regionally manufactured material.
      b. Include statement indicating location of manufacturer and point of extraction, harvest, or recovery for each raw material used in regionally extracted and manufactured materials. Indicate distance to Project and fraction by weight of each regionally manufactured material that is regionally extracted.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.4 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

B. Coordinate sizes and locations of fire-protection cabinets with wall depths.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.

2.2 FIRE-PROTECTION CABINET

A. Cabinet Type: Suitable for fire extinguisher.

1. Basis-of-Design Product: Subject to compliance with requirements, provide JL Industries, Ambassador Series, Model No. 2012-W-10-LDCVRFE or comparable product by one of the following:
   b. GMR International Equipment Corporation.
   c. Guardian Fire Equipment, Inc.
   d. Larsens Manufacturing Company.
   e. Modern Metal Products, Division of Technico Inc.
   f. Nystrom, Inc.
   g. Potter Roemer LLC.
   h. Strike First Corporation of America.

B. Cabinet Construction: Nonrated.

C. Cabinet Material: Cold-rolled steel sheet.

D. Semi-recessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
   1. Rolled-Edge Trim: 4-inch (102-mm) backbend depth.

E. Cabinet Trim Material: Same material and finish as door.

F. Door Material: Steel sheet.

G. Door Style: Vertical duo panel with frame.

H. Door Glazing: Clear acrylic.

I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

J. Accessories:
   1. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated.
IDENTIFY FIRE EXTINGUISHER IN FIRE-PROTECTION CABINET WITH THE WORDS "FIRE EXTINGUISHER."

1) Location: Applied to cabinet door.
3) Lettering Color: Red.
4) Orientation: Vertical.

K. Materials:

1. Cold-Rolled Steel: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
   a. Finish: Baked enamel or powder coat.
   b. Color: As selected by Architect from full range of industry colors and color densities.

L. Quantities and Location

1. Provide as shown on the drawings.
2. Provide (2) additional to be located in the field as required by the fire department.

PART 3 - EXECUTION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

END OF SECTION 10 44 13
SECTION 10 44 16 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes portable, hand-carried fire extinguishers.

B. Related Sections:
   1. Section 018113 – Sustainability Requirements

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
   1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content.
   2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regionally manufactured and regionally extracted and manufactured materials. Include statement indicating cost for each regionally manufactured material.
      a. Include statement indicating location of manufacturer and distance to Project for each regionally manufactured material.
      b. Include statement indicating location of manufacturer and point of extraction, harvest, or recovery for each raw material used in regionally extracted and manufactured materials. Indicate distance to Project and fraction by weight of each regionally manufactured material that is regionally extracted.

1.3 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.
1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Amerex Corporation.
b. Ansul Incorporated.
c. Badger Fire Protection.
d. Buckeye Fire Equipment Company.
e. Fire End & Croker Corporation.
f. Guardian Fire Equipment, Inc.
g. JL Industries, Inc.; a division of the Activar Construction Products Group.
h. Kidde Residential and Commercial Division; Subsidiary of Kidde plc.
i. Larsens Manufacturing Company.
j. Moon American.
k. Nystrom Building Products.
l. Pem All Fire Extinguisher Corp.
m. Potter Roemer LLC.
n. Pyro-Chem; Tyco Safety Products.
o. Strike First Corporation of America.

2. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

B. Multipurpose Dry-Chemical Type: UL-rated 10 lbs. nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine fire extinguishers for proper charging and tagging.
   1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Install fire extinguishers in locations indicated and in compliance with requirements of authorities having jurisdiction.

C. Install at all locations indicated in the drawings, all locations indicated on drawings to receive a fire extinguisher cabinet, and provide (2) additional to be located in the field by fire department
SECTION 105016 - WOOD LOCKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section includes wood-faced wood lockers

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
      1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of wood locker.
   B. Shop Drawings: For wood lockers.
      1. Include plans, elevations, sections, and attachment details.
      2. Show details full size.
      3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
      4. Show locations and sizes of cutouts and holes for items installed in lockers.
      5. Show locker fillers, trim, base, sloping tops, and accessories.
      6. Show locker identification system and numbering sequence.
   C. Samples for Initial Selection: For each type of the following:
      1. Factory-applied transparent finishes.
      2. Thermoset decorative overlay panels.

1.4 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For Installer.
   B. Sample Warranty: For special warranty.
1.5 CLOSEOUT SUBMITTALS
   A. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

1.6 QUALITY ASSURANCE
   A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
   B. Source Limitations: Obtain wood lockers through one source from a single manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING
   A. Do not deliver lockers until painting and similar operations that could damage lockers have been completed in installation areas. If lockers must be stored in other-than-installation areas, store only in areas where environmental conditions are the same as those in final installation location, and comply with requirements specified in "Field Conditions" Article.

1.8 FIELD CONDITIONS
   A. Environmental Limitations: Do not deliver or install wood lockers until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity at occupancy levels during the remainder of the construction period.
   B. Field Measurements: Where lockers are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings.
   C. Established Dimensions: Where wood lockers are indicated to fit to other construction, establish dimensions for areas where lockers are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.9 COORDINATION
   A. Coordinate sizes and locations of concealed wood support bases.
      1. Requirements are specified in Section 061000 "Rough Carpentry."
   B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that wood lockers can be supported and installed as indicated.
1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of lockers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures.
   b. Faulty operation of locks and other hardware.
   c. Deterioration of wood, wood finishes, and other materials beyond normal use.

2. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
   1. Hollman, Inc.
   2. Dimension Millworks.

2.2 MATERIALS

A. Medium-Density Fiberboard: ANSI A208.2, Grade MD-Exterior Glue.
B. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue, minimum 45-lb/cu. ft. (720-kg/cu. m) density.
C. Hardwood Face Veneers: HPVA HP-1, Grade A.
D. Thermoset Decorative Overlay: Particleboard complying with ANSI A208.1, Grade M-2, or medium-density fiberboard complying with ANSI A208.2, Grade MD, with surface of thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.
   1. Provide material made from particleboard or medium-density fiberboard made without urea formaldehyde.
E. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.
F. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage.
   1. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance.
   2. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.
2.3 WOOD LOCKER HARDWARE
   A. Frameless Hinges (European Type): Fully concealed, self-closing, nickel-plated steel, with not less than 125 degrees of opening.
      1. Provide two hinges for doors 42 inches high and less.
      2. Provide three hinges for doors more than 42 inches high.
   B. Wire Pulls: Back mounted; 4 inches long, 5/16 inch in diameter.
   C. Shelf Rests: BHMA A156.9, B04013.
   D. Hooks: Manufacturer's standard, ball-pointed aluminum or steel; finished to match other locker hardware. Attach hooks with at least two fasteners.
   E. Coat Rods: 1-inch-diameter steel; finished to match other locker hardware.
      1. Provide coat rod for each compartment of double-tier lockers.
   F. Exposed Hardware Finish: Satin chrome unless otherwise indicated.

2.4 DOOR LOCKS
   A. General: Fabricate wood lockers to receive locking devices. Provide one locking device for each wood locker door, unless otherwise indicated.
   B. Cam Padlock Hasp: Surface mounted, steel; finished to match other locker hardware.

2.5 WOOD-FACED WOOD LOCKERS
   A. Construction Style: Flush overlay.
   B. Locker Arrangement: Double tier.
   C. Locker body: Fabricated from particleboard fire-resistant-particle-core panels covered on both sides with thermoset decorative overlay.
      1. Side panels: Manufacturer’s standard 3/4 or 5/8 inch (19 or 16mm) thick.
      2. Back panels: Manufacturer’s standard 1/2 or 3/8 inch (13 or 9.5 mm) thick.
      3. Top panels: Manufacturer’s standard 3/4 or 5/8 inch (19 or 16 mm) thick.
      4. Bottom panels: Manufacturer’s standard 3/4 or 5/8 inch (19 or 16 mm) thick.
      5. Exposed Panel Edges: Solid wood to match doors.
   D. Flush, Wood-veneer-faced doors: Wood veneer applied over 3/4 inch(19-mm) thick particleboard core.
      1. Wood species and cut as follows:
         a. White maple
   E.
1.

A. Construction Style: Flush overlay.

B. Locker Arrangement: Double tier.

C. Locker Body: Fabricated from particleboard fire-resistant-particleboard-core panels covered on both sides with thermoset decorative overlay,
   1. Side Panels: Manufacturer's standard 3/4 or 5/8 inch (19 or 16 mm) thick.
   2. Back Panel: Manufacturer's standard 1/2 or 3/8 inch (13 or 9.5 mm) thick.
   3. Top Panel: Manufacturer's standard 3/4 or 5/8 inch (19 or 16 mm) thick.
   4. Bottom Panel: Manufacturer's standard 3/4 or 5/8 inch (19 or 16 mm) thick.
   5. Exposed Panel Edges: Solid wood to match doors.

D. Flush, Wood-Veneer-Faced Doors: Wood veneer applied over 3/4-inch- (19-mm-) thick, particleboard core,
   1. Wood species and cut as follows:
      a. White Maple, plain sawn.
   2. Wood Edges: 1/4-inch- (6-mm-) thick solid wood of same wood species as face veneer.

E. End Panels: Match style, material, construction, and finish of wood-faced wood doors.

F. Shelves: Fabricated from particleboard-core panels covered on both sides with thermoset decorative overlay; fixed.
   1. Thickness: 3/4 inch (19 mm).
   2. Exposed Edges: Solid wood to match doors.

G. Corners and Filler Panels: Wood-veneer-faced, 3/4-inch- (19-mm-) thick panel that matches door faces.

H. Grain Matching: Run and match grain vertically for doors and fixed panels.

I. Venting: Hold locker tops, bottoms, and shelves back 1/8 inch to allow adequate natural air flow.
2.6 LOCKER ACCESSORIES

A. Hooks: Manufacturer's standard zinc-plated, ball-pointed steel. Provide 1 double-prong ceiling hook and not fewer than 2 single-prong wall hooks. Attach hooks with at least two fasteners.

B. Number Plates: 1-1/2-inch-(38-mm-) diameter, etched, embossed, or stamped, stainless-steel plates with black numbers and letters at least 1/2 inch (13 mm) high. Identify wood lockers in sequence indicated on Drawings. Finish plates to match other wood locker hardware.

C. Continuous Finish Base: Wood-veneer-faced, 3/4-inch-(19-mm-) thick panel that matches door faces; fabricated in lengths as long as practicable to enclose base and base ends of wood lockers.

D. Continuously Sloping Tops: Wood-veneer-faced, 3/4-inch-(19-mm-) thick panel that matches door faces for installation over wood lockers with separate flat tops. Fabricate tops in lengths as long as practicable, without visible fasteners at splice locations. Provide fasteners, supports, and closures, as follows:


2.7 WOOD LOCKER FABRICATION

A. Unit Principle: Fabricate each wood locker with an individual door and frame, individual top, bottom, back, and shelves, and common intermediate uprights separating compartments.

   1. Fabricate wood lockers to dimensions, profiles, and details indicated.
   2. Ease edges of corners of solid wood members to radius of 1/16 inch (1.5 mm).

B. Fabricate components square, rigid, without warp, and with finished faces flat and free of scratches and chips. Accurately machine components for attachments in factory, with no chips. Make joints tight and true.

   1. Fabricate wood lockers using European 32-mm doveled and glued construction.

C. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

   1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.

D. Shop cut openings, to maximum extent possible, to receive hardware, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

2.8 FACTORY FINISHES FOR WOOD-FACED WOOD LOCKERS

A. General: Finish wood lockers at factory as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
B. Preparations for Finishing: Sand, fill countersunk fasteners, seal concealed surfaces, and perform similar preparations for finishing wood lockers, as applicable to each unit of work.
   1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of wood lockers. Apply two coats to back of paneling and to end-grain surfaces. Concealed surfaces of plastic-laminate-clad wood lockers do not require backpriming when surfaced with thermoset decorative overlay or plastic laminate.

C. Transparent Finish: Manufacturer’s standard two-coat, clear, catalyzed lacquer finish with sanding between coats. Seal with moisture-resistant topcoat.
   1. Stain: to match architect’s sample

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and floors or support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify that furring is attached to concrete and masonry walls that are to receive lockers.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Condition lockers to average prevailing humidity conditions in installation areas before installation.

B. Before installing lockers, examine factory-fabricated work for completeness and complete work as required, including removal of packing.

3.3 INSTALLATION

A. Install wood support base with 1/2-inch-thick, plywood top.

B. Install lockers level, plumb, and true; use concealed shims.

C. Connect groups of lockers together with manufacturer's standard brass-finished fasteners, through predrilled holes, with no exposed fasteners on face frames. Fit lockers accurately together to form flush, tight, hairline joints.

D. Install lockers without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings, providing unencumbered operation. Complete installation of hardware and accessory items as indicated.
1. Installation Tolerance: No more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line. Shim as required with concealed shims.

E. Locker Anchorage: Fasten lockers through back, near top and bottom, at ends with No. 8 flush-head wood screws sized for 1-inch penetration into wood framing, blocking, or furring and spaced not more than 16 inches o.c.

F. Scribe and cut corner and filler panels to fit adjoining work using fasteners concealed where practical. Repair damaged finish at cuts.

G. Attach sloping-top units to lockers, with end panels covering exposed ends.

H. Install number identification plates after lockers are in place.
   1. Attach number identification plate on each locker door, near top, centered, with at least two screws with finish matching the plate.
   2. Attach name identification plate holder on each locker door, centered below number plate, with at least two screws, with finish matching the name identification plate holder.
   3. Insert name identification plate into matching nameplate holder on each door.

3.4 ADJUSTING

A. Clean, lubricate, and adjust hardware. Adjust doors to operate easily without binding. Verify that integral locking devices operate properly.

3.5 PROTECTION

A. Protect lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.

B. Touch up marred finishes, or replace lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 105016
SECTION 12 24 13 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 SUMMARY
   
   A. Section includes manually roller shades.
   
   B. Related Sections
      1. Section 018113 – Sustainability requirements

1.2 ACTION SUBMITTALS
   
   A. Product Data: For each type of product.
      1. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.
   
   B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.
   
   C. Samples: For each exposed product and for each color and texture specified.
   
   D. LEED Submittals:
      1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content.
      2. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regionally manufactured and regionally extracted and manufactured materials. Include statement indicating cost for each regionally manufactured material.
         a. Include statement indicating location of manufacturer and distance to Project for each regionally manufactured material.
         b. Include statement indicating location of manufacturer and point of extraction, harvest, or recovery for each raw material used in regionally extracted and manufactured materials. Indicate distance to Project and fraction by weight of each regionally manufactured material that is regionally extracted.

1.3 CLOSEOUT SUBMITTALS
   
   A. Maintenance data.

1.4 QUALITY ASSURANCE
   
   A. Installer Qualifications: Fabricator of products.
B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Draper Inc.
   3. MechoShade Systems, Inc.

2.2 ROLLER SHADES

A. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.

   1. Bead Chains: Manufacturer's standard.
      a. Loop Length: Full length of roller shade.
      b. Limit Stops: Provide upper and lower ball stops.
      c. Chain-Retainer Type: Clip, jamb mount.

      a. Provide for shadebands that weigh more than 10 lb (4.5 kg) or for shades as recommended by manufacturer, whichever criteria are more stringent.

B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

   1. Roller Mounting Configuration: Single roller
   2. Roller Drive-End Location: Right side of inside face of shade
   3. Direction of Shadeband Roll: Regular, from back of roller
   4. Shadeband-to-Roller Attachment: Manufacturer's standard method
C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.

D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.

E. Shadebands:
   2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
      a. Type: Enclosed in sealed pocket of shadeband material
      b. Color and Finish: As selected by Architect from manufacturer's full range.

F. Installation Accessories:
   1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
      a. Shape: L-shaped.
      b. Height: Manufacturer's standard height required to conceal roller and shadeband when shade is fully open, but not less than 4 inches (102 mm)
   2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
      a. Height: Manufacturer's standard height required to enclose roller and shadeband when shade is fully open, but not less than 4 inches (102 mm)
      b. Provide end caps where the end is exposed.
   3. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.3 SHADEBAND MATERIALS

A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

B. Light-Filtering Fabric: Woven fabric, stain and fade resistant, greenguard certified
   2. Type: PVC-coated fiberglass
   3. Weave: Mesh
   4. Openness Factor: 1% percent at all locations except for meeting room. This Room shall be black out shades.
   5. Color: As selected by Architect from manufacturer's full range.
2.4 ROLLER-SHADE FABRICATION

A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.

B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F (23 deg C):

1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch (6 mm) per side or 1/2-inch (13-mm) total, plus or minus 1/8 inch (3.1 mm). Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch (6 mm), plus or minus 1/8 inch (3.1 mm).

2. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.

C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible except as follows:

1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.

2. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of shadeband.

PART 3 - EXECUTION

3.1 ROLLER-SHADE INSTALLATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Install roller shades level, plumb, and aligned with adjacent units, according to manufacturer's written instructions.

1. Opaque Shadebands: Located so shadeband is not closer than 2 inches (50 mm) to interior face of glass. Allow clearances for window operation hardware.

D. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

E. Clean roller-shade surfaces after installation, according to manufacturer's written instructions.
SECTION 123661 - SIMULATED STONE COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Solid-surface-material countertops, window sills, and backsplashes.

B. Related Sections:
   1. Section 018113 – Sustainability Requirements

1.2 ACTION SUBMITTALS

A. Product Data: For countertop materials

B. LEED Submittals:
   1. Certificates for Credit MR 7: Chain-of-custody certificates indicating that wood products comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
   2. Product Data for Credit IEQ 4.4: For adhesives and composite wood products, documentation indicating that product contains no urea formaldehyde.
   3. Laboratory Test Reports for Credit IEQ 4: For adhesives sealants and composite wood and agrifiber products, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.

D. Samples: For each type of material exposed to view.

PART 2 - PRODUCTS

2.1 SOLID-SURFACE-MATERIAL COUNTERTOPS

A. Configuration: Provide countertops with the following front and backsplash style:
   1. Front: [Radius edge with apron, 2 inches (50 mm) high with 3/8-inch (9.5-mm) radius
   2. Backsplash: Straight, slightly eased at corner.
2.2 COUNTERTOP MATERIALS

A. Certified Wood Materials: Fabricate countertops with wood and wood-based products produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

B. Composite Wood and Agrifiber Products: Provide products that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

C. Particleboard: ANSI A208.1, Grade M-2 made with binder containing no urea formaldehyde.

D. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

E. Adhesives: Adhesives shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. Solid Surface Material: Homogeneous solid sheets of filled plastic resin complying with ANSI SS1.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following

   a. Avonite Surfaces.
   c. Formica Corporation.
   d. LG Chemical, Ltd.
   e. Meganite Inc.
   f. Samsung Chemical USA, Inc.
   g. Swan Corporation (The).
   h. Transolid, Inc.
   i. Wilsonart International.

2. Type: Provide Custom Type unless Special Purpose Type is indicated.

3. Integral Sink Bowls: Comply with ISSFA-2 and ANSI Z124.3, Type 5 or Type 6, without a precoated finish.

4. Colors and Patterns: As selected by Architect from manufacturer's full range.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

END OF SECTION 123661
SECTION 124816 - ENTRANCE FLOOR GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes recessed floor grilles and frames.

B. Related Sections
   1. Section 018113 – Sustainability Requirements

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Items penetrating floor grilles and frames, including door control devices.
   2. Divisions between grille sections.
   3. Perimeter floor moldings.

C. Samples: For foot grilles and frame members.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Arden Architectural Specialties, Inc.
   2. Balco, Inc.
   5. C/S Group.
   8. Mats Inc.
   9. Pawling Corporation; Architectural Products Division.
  10. Reese Enterprises, Inc.
2.2 ENTRANCE FLOOR GRILLES, GENERAL


2.3 FLOOR GRILLES

A. Aluminum Floor Grilles: Provide manufacturer's standard floor grilles with extruded members, top-surfaced tread rails, and as follows:
   2. Tread Rail Spacing: 2 inches (50 mm) o.c. with 1/4-inch- (6.4-mm-) wide openings between treads.
   3. Top Surface: Fusion-bonded, level-cut-pile nylon carpet insert; 1/4 inch (6.4 mm) high, 28 oz./sq. yd. (950 g/sq. m).
      a. Top Surface Color: As selected by Architect from manufacturer's full range of industry colors.
   4. Grille Size: As indicated.

B. Lockdown: Manufacturer's standard.

2.4 FRAMES

A. Provide manufacturer's standard frames of size and style for grille type.

2.5 SUPPORT SYSTEM

A. Drainage Pit Applications: Provide manufacturer's special deep-pit frame and support extrusion system with intermediate support beams, sized and spaced as recommended by manufacturer for indicated spans and equipped with vinyl support cushions.

2.6 DRAIN PANS

A. Provide manufacturer's standard aluminum sheet drain pan with NPS 2 (DN 50) drain outlet for each floor-grille unit. Coat bottom of pan with protective coating recommended by manufacturer.

2.7 MATERIALS

A. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.
B. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304.
E. Stainless-Steel Angles: ASTM A 276 or ASTM A 479/A 479M, corrosion resistant, Type 304.

2.8 FABRICATION
A. Shop fabricate floor grilles to greatest extent possible in sizes as indicated.
B. Fabricate frame members in single lengths or, where frame dimensions exceed maximum available lengths, provide minimum number of pieces possible.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install recessed floor grilles and frames and drain pans to comply with manufacturer's written instructions at locations indicated and with top of floor grilles and frames in relationship to one another and to adjoining finished flooring as recommended by manufacturer. Set floor-grille tops at height for most effective cleaning action. Coordinate top of floor-grille surfaces with doors that swing across grilles to provide clearance under door.

3.2 PROTECTION
A. After completing frame installations, provide temporary filler of plywood or fiberboard in floor-grille recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Substantial Completion.

END OF SECTION 124816
SECTION 129300 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes bicycle racks.

B. Related Sections:
   1. Section 018113 – Sustainability Requirements

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
   1. Product Data for Credit MR 4.1: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

C. Samples: For each exposed product and for each color and texture specified.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

PART 2 - PRODUCTS

2.1 BICYCLE RACKS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Rolling Rack Bike Rack – Model No. RR3H by Dero Bike Rack Co. or comparable product by one of the following:

   1. A A A Ribbon Rack Co., Inc.; Division of Brandir International, Inc.
   3. BCI Burke Company, LLC.
   4. BRP Enterprises, Inc.
   7. Cora Bike Rack.
   8. Creative Pipe, Inc.
2.2 FABRICATION

A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.

B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.

C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.

D. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.

E. Factory Assembly: Assemble components in the factory to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

2.3 ALUMINUM FINISHES

A. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.

B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.

C. Install site furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.

END OF SECTION 129300
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SECTION 21 05 17 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Sleeves.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES
A. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Advance Products & Systems, Inc.
   2. Metraflex Company (The).
   3. Pipeline Seal and Insulator, Inc.
B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Carbon steel.
   3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.
PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.
   1. Sleeves are not required for core-drilled holes.

C. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

D. Fire-Barrier Penetrations: Maintain fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Interior Partitions:
      a. Piping Smaller Than NPS 6 (DN 150): PVC-pipe sleeves.

END OF SECTION 21 05 17
SECTION 21 05 18 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Escutcheons.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls and ceilings.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.

b. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.

c. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.

d. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.
3.2 FIELD QUALITY CONTROL

   A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 21 05 18
SECTION 21 05 53 - IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Pipe labels.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Material and Thickness: Brass, 0.032 inch (0.8 mm), stainless steel, 0.025 inch (0.64 mm), or aluminum, 0.032 inch (0.8 mm) thick, with predrilled holes for attachment hardware.
   2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
   3. Minimum Letter Size: 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, with predrilled holes for attachment hardware.
   2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
   3. Minimum Letter Size: 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules).

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; pipe size; and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches (38 mm) high.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 LABEL INSTALLATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install or permanently fasten labels on each major item of fire system equipment.

D. Locate equipment labels where accessible and visible.

E. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; accessible maintenance spaces such as plenums; and locations as follows:
   1. Near each valve and control device.
   2. At access doors and similar access points that permit view of concealed piping.
3. Near major equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.

END OF SECTION 21 05 53
SECTION 21 13 13 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection valves.

1.2 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device.

1.3 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.

B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified state of Ohio certified designer, using performance requirements and design criteria indicated.

1. Use fire-hydrant flow test records or provide flow test to permit design of system modifications.

C. Sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications:
   a. General areas - light hazard.
3. Minimum Density for Automatic-Sprinkler Piping Design:
   a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. (4.1 mm/min. over 139-sq. m) area.
   b. Ordinary-Hazard Occupancy: 0.15 gpm over 1500-sq. ft. (6.1 mm/min. over 139-sq. m) area.
4. Maximum Protection Area per Sprinkler:
   a. 225 sq. ft. (20.9 sq. m).
   b. Storage Areas: 130 sq. ft. (12.1 sq. m) ordinary hazard.

5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
   a. Light-Hazard Occupancies: 100 gpm (6.3 L/s) for 30 minutes.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.

C. Qualification Data: For qualified Installer.

D. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

1.5 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing engineering services needed to assume engineering responsibility. Base calculations on results of flow test data.
      a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a certified designer.

B. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
   1. NFPA 13, "Installation of Sprinkler Systems."
PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

A. Standard Weight, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Malleable- or Ductile-Iron Unions: UL 860.


D. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.


F. Grooved-Joint, Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Tyco Fire & Building Products LP.
   b. Victaulic Company.

2. Pressure Rating: 175 psig (1200 kPa) minimum.

3. Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.

4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.

   1. Class 125, Cast-Iron Flat-Face Flanges: Full-face gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 LISTED FIRE-PROTECTION VALVES

A. General Requirements:
   1. Valves shall be UL listed or FM approved.

B. Check Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Reliable Automatic Sprinkler Co., Inc.
      b. Tyco Fire & Building Products LP.
      c. Victaulic Company.
      d. Viking Corporation.
   3. Pressure Rating: 250 psig (1725 kPa) minimum.
   4. Type: Swing check.
   5. Body Material: Cast iron.
   6. End Connections: Flanged or grooved.

C. Indicating-Type Butterfly Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Tyco Fire & Building Products LP.
      b. Victaulic Company.
   2. Standard: UL 1091.
   3. Pressure Rating: 175 psig (1200 kPa) minimum.
   4. Valves NPS 2 (DN 50) and Smaller:
      a. Valve Type: Ball or butterfly.
      b. Body Material: Bronze.
      c. End Connections: Threaded.
   5. Valves NPS 2-1/2 (DN 65) and Larger:
      a. Valve Type: Butterfly.
      b. Body Material: Cast or ductile iron.
      c. End Connections: Flanged, grooved, or wafer.
6. Valve Operation: Integral electrical, 115-V ac, prewired, two-circuit, supervisory switch and visual indicating device.

2.5 TRIM AND DRAIN VALVES

A. General Requirements:


B. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Tyco Fire & Building Products LP.
   b. Victaulic Company.
   c. Watts Water Technologies, Inc.

2.6 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Tyco Fire & Building Products LP.
   b. Victaulic Company.

3. Pressure Rating: 175 psig (1200 kPa) minimum.
5. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Sprinkler Inspector's Test Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Tyco Fire & Building Products LP.
   b. Victaulic Company.
   c. Viking Corporation.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

2.7 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco Fire & Building Products LP.
3. Victaulic Company.

B. General Requirements:

2. Pressure Rating for Automatic Sprinklers: 175 psig (1200 kPa) minimum.

C. Sprinkler Finishes:

1. Painted.

D. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

E. Sprinkler Guards:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Reliable Automatic Sprinkler Co., Inc.
   b. Tyco Fire & Building Products LP.
   c. Victaulic Company.
   d. Viking Corporation.

2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.
2.8  ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Flow Indicators:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. System Sensor; a Honeywell company.
   c. Viking Corporation.

4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
7. Design Installation: Horizontal or vertical.

C. Valve Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Kennedy Valve; a division of McWane, Inc.
   b. Potter Electric Signal Company.
   c. System Sensor; a Honeywell company.

3. Type: Electrically supervised.
5. Design: Signals that controlled valve is in other than fully open position.

PART 3 - EXECUTION

3.1  WATER-SUPPLY CONNECTIONS

A. Connect sprinkler piping to pipe stub within mechanical room.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping.
C. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.2 PIPING INSTALLATION

A. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

B. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

C. Install sprinkler piping with drains for complete system drainage.

D. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

E. Fill sprinkler system piping with water.

F. Install sleeves for piping penetrations of walls and ceilings. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

G. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.3 JOINT CONSTRUCTION

A. Install couplings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

E. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

F. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

G. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

3.4 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

3.5 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.

3.6 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
3. Energize circuits to electrical equipment and devices.
4. Coordinate with fire-alarm tests. Operate as required.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.8 CLEANING

A. Clean dirt and debris from sprinklers.
3.9 PIPING SCHEDULE

A. Wet-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
3. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.

B. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 (DN 65) and larger, shall be the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
3. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.
4. Thinwall Schedule 10, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.10 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended or Drywall Ceilings: Concealed sprinklers.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.

END OF SECTION 21 13 13
PART 1 - GENERAL CONDITIONS

1.1 SCOPE

A. All provisions of the bidding requirements, including General and Supplementary Conditions and Division 01 Specification Sections, apply to work in this Division.

B. The scope of the plumbing work includes, but not limited to, furnishing, installing, testing, and warranty of all plumbing work and complete plumbing systems shown on the plumbing drawings and specified herein.

C. Plumbing shall be installed by a licensed contractor.

D. The word “provide” shall be defined to mean “furnish and install, complete, and operating.”

E. Where the word “equal to” is used, the Contractor shall have the option of selecting between one of the additional names or manufacturers listed or may submit products subject to Engineer’s approval.

F. Refer to Division 01 “General Requirements” for alternates, which may affect the plumbing work.

1.2 INSPECTION OF SITE

A. Each bidder shall inspect the project site before submitting a bid. Report to the Architect any significant discrepancies from information shown on the drawings or indicated in specifications. No allowance will be made for failure to have made a thorough inspection after the contract is signed.

1.3 PERMITS AND REGULATIONS

A. Include payment of all permit and inspection fees applicable to the plumbing work in this Division.

B. Furnish the Owner certificates of approval from the governing inspection agencies as a condition of final payment.

C. Work must conform to applicable local, state, and federal laws, ordinances, and regulations. Where Drawings or Specifications exceed code requirements, the Drawings and Specifications shall govern. Do not install work contrary to minimum legal standards.

1.4 ASBESTOS MATERIALS
A. Abatement, removal, or encapsulation of existing materials containing asbestos is not included in this Contract. Necessary work of this nature will be arranged by the Owner to be done outside of this construction by a company regularly engaged in asbestos abatement. Such work will be performed prior to start of work in this project.

B. If, in the performance of the work, materials are observed which are suspected to contain asbestos, the Contractor shall immediately inform the Architect/Engineer who in turn will notify the Owner. Work shall be terminated until a determination has been made that unsafe materials have been removed or encapsulated and the area declared safe.

1.5 DRAWINGS AND SPECIFICATIONS

A. The drawings indicate the general arrangement of the work and shall be followed insofar as possible. If deviations are necessitated by field conditions, provide proposed layout to the Architect and Engineer for approval before proceeding with the work.

B. The drawings and specifications shall be reviewed during the course of bidding and construction. Any errors, omissions, or discrepancies encountered shall be referred to the Architect for interpretation or correction. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having pipe and fittings fabricated before making actual measurements shall not be sufficient cause to avoid making offsets and minor changes as may be necessary to install piping and equipment.

C. The Architect shall reserve the right to make minor adjustment in locations of components to conceal work or present a better appearance where exposed. Changes shall be anticipated and requested in advance as to not cause extra work, or unduly delay the work.

D. Equipment or piping shall not be installed in the working space required above or around electrical equipment as identified by the National Electric Code (NEC).

E. Provide offsets, additional fittings, piping, and devices as required to provide a complete workable installation.

F. Should overlap of work among the trades become evident, the Architect shall provide written instructions determining who is responsible for work.

1.6 AGREEMENT AND WAIVER FOR USE OF COMPUTER AIDED DESIGN FILES

A. The Engineering, at his sole discretion and without obligation may make graphic portions of the contract documents available for use by Plumbing Contractor in an electronic format. The electric documents provided by the Engineer are proprietary and remain the Engineer’s Instruments of Service and shall be for use solely with respect to this project as provided in the Standard Form of Agreement between Owner/Architect and Engineer.

B. Electronic files will be provided only after the bids have been received and contracts have been signed with the contractors.
C. The Contractor shall acknowledge receipt of AutoCAD files in .DXF or .DWG format for this project. These files are provided for use in preparing shop drawings and/or coordination drawings. These files and the information contained within are the property of Woolpert, Inc. and/or the Architect and/or the Owner, and may not be reproduced or used in any format except in conjunction with the project.

D. The User acknowledges that the information provided in these files is not a substitution or replacement for the Contract Documents and does not become a Contract Document. The User acknowledges that neither Woolpert, Inc., the Architect, the Consultant, the Client, or the Owner make any warrant or representation that the information contained in these files reflect the Contract Documents in their entirety. The User assumes full responsibility in the use of these files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications, and change orders to the drawings executed as a part of the Contract Documents have been incorporated.

E. These electronic documents are available in the .DWG format for AutoCAD and are available at the Engineer’s office. A sample of the format will be provided by the Engineer upon request by the Contractor for the purpose of testing the compatibility of the format to the Contractor’s system.

F. Projects developed using AutoCAD MEP or REVIT will have all drawings converted to the AutoCAD format. AutoCAD MEP or REVIT documents will not be furnished unless under a separate Contractual Agreement.

G. The electronic documents will be stripped of the project’s name and address, the Architect’s and/or Engineer’s and/or Consultant’s name and address and any professional licenses indicated on the contract document and all dimensions, verbiage, and statistical information. Use of these electronic documents is solely at the Contractor’s risk and shall in no way alter the Contractor’s Contract.

H. The User/Contractor agrees to indemnify, hold harmless, and defend Woolpert, Inc., the Architect, the Consultant, the Owner, the Client, and any of their agents from any litigation resulting from the use of these files. The Engineer makes no representation regarding fitness, suitability, or use with any software or hardware, and shall not be responsible or liable for errors and defects. The Contractor waives all claims against the Engineer for any and all damages, losses, or expenses the Contractor incurs from such defects or errors in the electronic documents.

1.7 SHOP DRAWINGS/SUBMITTALS

A. Six sets of shop drawings and descriptive information shall be assembled by the Contractor of equipment and materials furnished in their contract, and submitted to the Architect and/or Engineer for review as stated in the General Conditions and Supplementary Conditions. These shall be submitted as soon as practicable and before equipment is installed and before special equipment is manufactured. Submittal information shall clearly identify the manufacturer, specific model number, approval labels, performance data, electrical characteristics, features, specified options and additional information sufficient to evidence compliance with the contract documents. Shop drawings for equipment, fixtures, devices, and materials shall be labeled and
identified same as on the Contract Documents. If compliance with the above criteria is not provided shop drawings will be subject to rejection and returned without review.

B. The review of shop drawings by the Architect and Engineer shall not relieve the Contractor from responsibility for errors or omissions in the shop drawings. Deviations from specifications and drawing requirements shall be indicated to draw attention on the submittal for the Engineer’s review.

C. Shop drawings of the following plumbing equipment and materials shall be submitted:

1. Pipe, fittings and joining methods for the various systems.
2. Firestopping systems for pipe penetrations.
3. Pipe hangers and saddles.
4. Valves.
5. Flexible connectors.
7. Pipe insulation.
8. Supply system specialties.
10. Drainage system specialties.
11. Plumbing fixtures and trim.
12. Water heating equipment.

1.8 COORDINATION DRAWINGS

A. The HVAC Contractor shall initially prepare coordination drawings. Drawings shall be produced using computer aided drafting of a mutually agreed upon format and distributed to Plumbing, Fire Suppression, and Electrical Contractors for their input. All contractors shall sign off their approval and then Drawings shall be submitted and reviewed by Engineer for approval prior to start of construction.

1.9 EQUIPMENT SELECTION

A. Alternative equipment selected by the Contractor that is not the basis of design and has different electrical characteristics, physical dimensions, weights, capacities, and ratings may be furnished provided such proposed equipment is accepted in writing by the Engineer. Additional requirements regarding connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, structural supports, and additional equipment spaces shall be reviewed by the Architect and Engineer. Additional costs for these modifications and any subsequent design shall be the responsibility of the installing contractor. The architect reserves the right to request installation drawings for such items. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design and commissioning requirements.

B. The selection of materials and equipment to be furnished under this contract shall be governed by the following:
1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specification, the exact equipment listed shall be furnished. Where more than one name is listed, the Contractor shall have the option of selecting between any one of those specified.

2. Where the words "or approved equal" appear after a manufacturer's name, specific approval must be obtained from the Architect/Engineer during the bidding period in sufficient time to be included in an addendum. Equipment and materials not named in the specifications or indicated on the drawings, where approval is sought shall be submitted in writing to the Engineer prior to bidding for approval.

3. Where the words "equal to" appear, followed by a manufacturer's name and/or model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.

1.10 OPERATING AND MAINTENANCE MANUALS

A. Provide three hard copies and two electronic copies of operating and maintenance manuals for all equipment included in the project. Manuals shall include equipment specifications, project specific capacities, safety requirements, routine maintenance requirements, major maintenance instructions and requirements, operation procedures, parts list and parts drawings.

B. Manual shall include pressure test reports, balance reports, and disinfection certificate.

C. These shall be assembled into three-ring loose leaf binders, An index and tabbed sheets to separate the sections shall be included. Manuals shall be submitted to Architect and Engineer for review. Upon approval, manuals shall be turned over to the Owner.

1.11 WARRANTIES

A. The Contractor shall warrant all materials, equipment, and workmanship. Provide original warranties for each piece of equipment were applicable. The warranty shall include the terms and conditions of the warranty. Each warranty shall include the date on which the warranty period started. The warranty period shall start on the date of substantial completion unless specific authorization has been given by the Architect to start the warranty period on an alternate date. If equipment is used after initial startup during construction phase of project (prior to substantial completion) it shall have an additional warranty provided to cover usage prior to substantial completion. Additional warranty shall provide the original projected warranty coverage period after substantial completion in addition to coverage for period of use prior to substantial completion. If additional warranty coverage is not provided, equipment shall not be used prior to substantial completion. In all cases the client must approve the use of any of their facility’s equipment prior to substantial completion (with the exception to startup, testing and balancing and commissioning).
B. Warranty shall not be construed to include maintenance items such as retightening or repacking glands, greasing oiling, belt tightening, or cleaning of strainers after these have been done for final closeout.

C. Provisions of this warranty shall be considered supplementary to warranty provisions under General Conditions.

1.12 TRAINING

A. Training shall be performed by the contractor or a factory authorized technician.

B. A sign off sheet or letter signed by the owner or using agency shall be provided to the Architect/Engineer to indicate that the training was satisfactorily provided.

1.13 FINAL INSPECTION AND PUNCHLIST

A. The Contractor shall survey and inspect their work and develop a punch list to confirm that all work is finished. Then notify the Architect and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected the work and so states at the time of the request for the final inspection.

B. Requests for final inspection may be accompanied by a list of known deficiencies in completion, with appropriate explanation and schedule for completing outstanding issues.

C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion, or verification. Corrective action shall be taken by the Contractor to the satisfaction of Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

D. Prepare test and inspection reports for submittal to Architect and/or Engineer. After review and approval, submit to Owner.

1.14 PIPE TESTING

A. All piping provided in the Plumbing Scope shall be pressure tested, as specified below.

B. Pipe testing for Plumbing piping shall be:

1. Underground Domestic Water Service: Hydrostatic at 125 psig or 1.5 times the maximum operation pressure, whichever is higher, for 6 hours, and in conformance with AWWA procedures.

2. Domestic Cold and Hot Water and Hot Water Recirculating Piping: Hydrostatic at 125 psig or 1.50 times the maximum operation pressure of the system, whichever is higher, for 6 hours.

4. Interior Natural Gas Piping: 25 psi compressed air for 4 hours. Provide a rough
test and final test for Corrugated Stainless Steel Tubing (CSST) in compliance
with the tubing manufacturers requirements.

5. Other Piping: Refer to appropriate Sections.

C. Testing shall be performed prior to application of insulation. Ensure that air is vented
from piping when piping is hydrostatically tested.

D. Tests shall be witnessed by field representatives of the Architect or Engineer or shall be
monitored by a recorder. Furnish a written record of each piping system test indicating
date, system, pressure, duration, and results of tests. Copies of test reports shall be
included in the O&M manuals.

E. Leaks discovered during testing shall not be patched. Threaded connections shall be
either tightened or replaced. Leaks in welded pipe may be chipped and rewelded. Leaks
in soldered pipe shall require replacement of pipe and/or fittings.

1.15 PIPE CLEANING

A. Before placing each water piping system in operation, the piping system shall be
thoroughly flushed out with clean water. Remove, clean and replace all strainer screens
after flushing is complete. On domestic water systems, remove, clean and replace all
fixture mounted strainer screens and faucet aerators after fixtures are set and connected
piping is flushed thru the fixtures.

1.16 DISINFECTION OF PIPING

A. Domestic water piping shall be disinfected by a company or personnel regularly engaged
in the performance of this service.

B. Thoroughly flush the system, as previously described, prior to disinfection. Disinfection
shall be performed in accordance with AWWA C651 Standards. Disinfection shall be by
means of a chlorine solution injected into the water system near the source. Each outlet
shall be tested to prove presence of minimum chlorine concentration. Document that
adequate levels of chlorine are present in each pipe section. Following the appropriate
retention period, flush out the system with clean water until the residual free chlorine
content is equal to the level of the incoming water, but not greater than 1.5 parts per
million or until approved by the Health Department.

C. Perform a bacteriological analysis of the potable water system. One test sample shall be
collected from the end of the main and one from each branch. Provide certification
stating the name of the lab performing the testing, the job name, the date of the sample,
and results of the testing.

D. Disinfection procedures shall be witnessed or approved by the Architect, Engineer or
other qualified representative, who shall present the contractor with a letter or certificate
of completion.
1.17 RECORD DRAWINGS

A. The Contractor shall maintain a separate set of prints of the Contract Documents and shall indicate all changes and variations in a manner to be clearly discernable which are made during construction. These drawings shall be turned over to the Architect upon completion of the work.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 22 01 00
SECTION 22 05 17 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL (NOT APPLICABLE)

PART 2 - PRODUCTS

2.1 SLEEVES

A. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

C. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

END OF SECTION 22 05 17
SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL (NOT APPLICABLE)

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener. Provide deep-pattern type where piping or sleeve protrudes beyond wall.

B. Escutcheons shall be provided with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 22 05 18
SECTION 22 05 19 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Liquid-in-glass thermometers.
2. Dial type pressure gauges.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

   a. Flo Fab Inc.
   b. Miljoco Corporation.
   d. Tel-Tru Manufacturing Company.
   e. Treice, H. O. Co.
   f. Weiss Instruments, Inc.
   g. Winters Instruments - U.S.

4. Case: Cast aluminum; 9-inch (229-mm) nominal size unless otherwise indicated.
5. Case Form: Adjustable angle unless otherwise indicated.
6. Tube: Glass with magnifying lens and blue or red organic liquid.
7. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
8. Window: Glass.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
   a. AMETEK, Inc.; U.S. Gauge.
   b. Ashcroft Inc.
   c. Ernst Flow Industries.
   d. Flo Fab Inc.
   e. Marsh Bellofram.
   f. MIljoco Corporation.
   g. Noshok.
   h. Palmer Wahl Instrumentation Group.
   i. REOTEMP Instrument Corporation.
   j. Tel-Tru Manufacturing Company.
   k. Trrice, H. O. Co.
   l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   m. Weiss Instruments, Inc.
   n. WIKA Instrument Corporation - USA.
   o. Winters Instruments - U.S.

4. Case: Liquid-filled type(s); cast aluminum or drawn steel; 6-inch (152-mm) nominal diameter.
5. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
8. Window: Glass.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending a minimum of 2 inches (51 mm) into fluid and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids.

H. Install thermometers in the following locations:
   1. Inlet and outlet of each water heater.

I. Adjust faces of meters and gages to proper angle for best visibility.

3.2 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be the following:
   1. Liquid-filled, sealed, bimetallic-actuated type.

B. Thermometer stems shall be of length to match thermowell insertion length.

3.3 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C).

B. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F (0 to 150 deg C).

3.4 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be the following:
1. Liquid-filled, sealed, mounted, metal case.

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 100 psi (0 to 600 kPa).

B. Scale Range for Domestic Water Piping: 0 to 100 psi (0 to 600 kPa).
PART 1 - GENERAL

1.1 SUMMARY
A. Provide brass or bronze valves per ASME B16.10, ASME B16.34, and NSF 61.

1.2 GENERAL REQUIREMENTS
A. Valve Sizes: Same as upstream piping unless otherwise indicated.
B. Handlever Actuator: For quarter-turn valves NPS 6 (DN 150) and smaller.
C. Valves in Insulated Piping: Shall be provided with 2-inch (50-mm) stem extensions with non-thermal-conductive material and protective sleeve.
D. Valve-End Connections:
   1. Solder Joint: With sockets according to ASME B16.18.
   2. Threaded: With threads according to ASME B1.20.1.

PART 2 - PRODUCTS

2.1 BRASS BALL VALVES
A. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim: Per MSS SP-110m 150 PSIG SWP rating, seats PTFE or TFE, brass stem, chrome plated brass ball.
   1. Acceptable Manufacturers:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Hammond Valve.
      c. NIBCO INC.
      d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2.2 BRONZE BALL VALVES
A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: Per MSS SP-110, 150 PSIG SWP rated, PTFE or TFFE seats, bronze stem chrome plated brass ball.
   1. Acceptable Manufacturers:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Hammond Valve.
c. NIBCO INC.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

PART 3 - EXECUTION

3.1 ADJUSTING

A. Adjust valve packing if leaking occurs. Replace valve if leaking occurs after adjusting.

END OF SECTION 22 05 23
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe positioning systems.
7. Equipment supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 591, Type VI, Grade I polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.6 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.
2.7 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
G. Install lateral bracing with pipe hangers and supports to prevent swaying.

H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

K. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
      b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
      c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
      d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.3 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).
B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.4 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
G. Use padded hangers for piping that is subject to scratching.
H. Use thermal-hanger shield inserts for insulated piping and tubing.
I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 10 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
16. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
17. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
18. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
19. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
5. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
6. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
7. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
8. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
10. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
11. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
12. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

   1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
   2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
   3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

Q. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 22 05 29
PART 1 - GENERAL

1.1 SUMMARY
A. Section includes plumbing piping heat tracing for domestic hot-water-temperature maintenance with the following electric heating cables:
   1. Self-regulating, parallel resistance.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Shop Drawings: For electric heating cable.

1.3 INFORMATIONAL SUBMITTALS
A. Field quality-control reports.
B. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS
A. Operation and maintenance data.

1.5 WARRANTY
A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
   1. Warranty Period: [Three] [Five] <Insert number> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES
A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
2. Chromalox.
3. Delta-Therm Corporation.
4. Easy Heat; a division of EGS Electrical Group LLC.
5. Nelson Heat Trace; a division of EGS Electrical Group LLC.
6. Pyrotenax; a brand of Tyco Thermal Controls LLC.
7. Raychem; a brand of Tyco Thermal Controls LLC.
8. Thermon Americas Inc.
9. Trasor Corp.

B. Comply with IEEE 515.1.

C. Heating Element: Pair of parallel No. 14 AWG, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

D. Electrical Insulating Jacket: Flame-retardant polyolefin.

E. Cable Cover: Tinned-copper braid and polyolefin outer jacket.

F. Maximum Operating Temperature (Power On): 150 deg F (65 deg C).

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Capacities and Characteristics:

3. Number of Parallel Cables: <Insert number>.
4. Electrical Characteristics for Single-Circuit Connection:

2.2 CONTROLS

A. Programmable Timer for Domestic Hot-Water-Temperature Maintenance:

1. Microprocessor based.
2. Minimum of four separate schedules.
3. Minimum 24-hour battery carryover.
4. On-off-auto switch.
5. 365-day calendar with 20 programmable holidays.
6. Relays with contacts to indicate operational status, on or off, and for interface with central HVAC control-system workstation.
2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Section 220553 "Identification for Plumbing Piping and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils (0.08 mm) thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
   1. Width for Markers on Pipes with OD, Including Insulation, Less Than 2 Inches (50 mm): 3/4 inch (19 mm) minimum.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Install the following types of electric heating cable for the applications described:

3.2 INSTALLATION

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

B. Electric Heating-Cable Installation for Temperature Maintenance for Domestic Hot Water:
   1. Install electric heating cables after piping has been tested and before insulation is installed.
   2. Install insulation over piping with electric heating cables according to Section 220719 "Plumbing Piping Insulation."
   3. Install warning tape on piping insulation where piping is equipped with electric heating cables.

C. Set field-adjustable switches and circuit-breaker trip ranges.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
   2. Test cables for electrical continuity and insulation integrity before energizing.
   3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

C. Cables will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

E. Remove and replace damaged heat-tracing cables.

END OF SECTION 22 05 33
SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL (NOT APPLICABLE)

PART 2 - PRODUCTS

2.1 PIPE LABELS

A. Labels shall be preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Label Contents: Include identification of piping service pipe size and an arrow indicating flow direction. Minimum 1-1/2 inches (38 mm) high.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide pipe labels where piping is exposed or above accessible ceilings in finished spaces.

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.

END OF SECTION 22 05 53
PART 1 - GENERAL

1.1 SUMMARY

   A. Section includes insulating the following plumbing piping services:
      1. Domestic hot-water piping.
      2. Supplies and drains for handicap-accessible lavatories and sinks.

1.2 ACTION SUBMITTALS

   A. Product Data: For each type of product indicated.

   B. LEED Submittals:
      1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.
      2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that product complies with the testing and product requirements of the California Department of Health Services"Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

   C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
      1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
      2. Detail attachment and covering of heat tracing inside insulation.
      3. Detail insulation application at pipe expansion joints for each type of insulation.
      4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
      5. Detail removable insulation at piping specialties, equipment connections, and access panels.
      6. Detail application of field-applied jackets.
      7. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

   A. Field quality-control reports.

1.4 QUALITY ASSURANCE

   A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having
jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

B. Comply with the following applicable standards and other requirements specified for miscellaneous components:


PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Fibrex Insulations Inc.; Coreplus 1200.
   b. Johns Manville; Micro-Lok.
   c. Knauf Insulation; 1000-Degree Pipe Insulation.
   d. Manson Insulation Inc.; Alley-K.
   e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 Deg F (454 Deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).


1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: 60 percent by volume and 66 percent by weight.

2.5 SEALANTS

A. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for pipe.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.

1. Sheet and roll stock ready for shop or field sizing.
2. Finish and thickness are indicated in field-applied jacket schedules.
3. Moisture Barrier for Indoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
4. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
5. Factory-Fabricated Fitting Covers:
a. Same material, finish, and thickness as jacket.
b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
c. Tee covers.
d. Flange and union covers.
e. End caps.
f. Beveled collars.
g. Valve covers.
h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Width: 3 inches (75 mm).
   2. Thickness: 11.5 mils (0.29 mm).
   3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.10 SECUREMENTS

A. Aluminum Bands: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

2.11 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:
   1. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.
   a. For below-ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve...
stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.
3.5 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
   4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

3.6 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

   1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.9 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Hot Water: Insulation shall be the following:

   1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
B. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities: Insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch (25 mm) thick.
2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
3. Polyolefin: 1 inch (25 mm) thick.

3.10 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:

1. None.
2. PVC: 30 mils (0.8 mm) thick.
3. Aluminum, Smooth: 0.016 inch (0.41 mm) thick.

END OF SECTION 22 07 00
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes water-distribution piping and related components outside the building for water service, fire service and combined fire and water service.

B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.

2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.

3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.

D. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

F. NSF Compliance:
   1. Comply with NSF 14 for plastic potable-water-service piping.
   2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.6 PROJECT CONDITIONS
A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
   1. Notify Architect and Owner no fewer than 2 days in advance of proposed interruption of service.
   2. Do not proceed with interruption of water-distribution service without Architect and Owner written permission.

1.7 COORDINATION
A. Coordinate connection to water main with utility company.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS
A. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) water tube, annealed temper.

B. Hard Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) water tube, drawn temper.

C. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

D. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Gaskets: AWWA C111, rubber.

E. PVC, AWWA Pipe: AWWA C900, Class 150, with bell end with gasket, and with spigot end.

1. Comply with UL 1285 for fire-service mains if indicated.
2. PVC Fabricated Fittings: AWWA C900, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
3. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
4. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
5. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

F.

2.2 JOINING MATERIALS

A. Refer to Section 330500 "Common Work Results for Utilities" for commonly used joining materials.

B. Brazing Filler Metals: AWS A5.8, BCuP Series.

C. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

D. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

2.3 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Tubular-Sleeve Pipe Couplings:
1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.


2.4 GATE VALVES

A. AWWA, Cast-Iron Gate Valves:

   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   3. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings or a comparable product by one of the following:

      d. Crane Co.; Crane Valve Group; Stockham Div.
      e. East Jordan Iron Works, Inc.
      f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
      g. McWane, Inc.; Kennedy Valve Div.
      h. McWane, Inc.; M & H Valve Company Div.
      i. McWane, Inc.; Tyler Pipe Div.; Utilities Div.
      j. Mueller Co.; Water Products Div.
      k. NIBCO INC.
      l. U.S. Pipe and Foundry Company.

   4. Nonrising-Stem, Resilient-Seated Gate Valves:

      a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.

         1) Standard: AWWA C509.
         2) Minimum Pressure Rating: 200 psig (1380 kPa).
         3) End Connections: Mechanical joint.
         4) Interior Coating: Complying with AWWA C550.

2.5 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:

   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

3. **Basis-of-Design Product:** Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

   b.  East Jordan Iron Works, Inc.
   c.  Flowserve.
   d.  McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
   e.  McWane, Inc.; Kennedy Valve Div.
   f.  McWane, Inc.; M & H Valve Company Div.
   g.  Mueller Co.; Water Products Div.
   h.  U.S. Pipe and Foundry Company.

4. Description: Sleeve and valve compatible with drilling machine.

   a. Standard: MSS SP-60.
   b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
   c. Valve: AWWA, cast-iron, nonrising-stem, metal resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches (125 mm) in diameter.

   1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

2.6 **CORPORATION VALVES AND CURB VALVES**

A. Manufacturers:

   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:

B. Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.

   1. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
   2. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.
3. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.

C. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.

D. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches (75 mm) in diameter.

   1. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

2.7 WATER METERS

A. Water meters will be furnished by utility company.

2.8 WATER METER BOXES

A. Description: Cast-iron body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping.

   1. Option: Base section may be cast-iron, PVC, clay, polyethylene or other pipe.

B. Description: Cast-iron body and double cover for disc-type water meter, with lettering "WATER METER" in top cover; and with separate inner cover; air space between covers; and slotted, open-bottom base section of length to fit over service piping.

C. Description: Polymer-concrete body and cover for disc-type water meter, with lettering "WATER" in cover; and with slotted, open-bottom base section of length to fit over service piping. Include vertical and lateral design loadings of 15,000 lb minimum over 10 by 10 inches (6800 kg minimum over 254 by 254 mm) square.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

C. Do not use flanges or unions for underground piping.

D. Flanges, unions, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

E. Underground water-service piping NPS 3/4 to NPS 3 (DN 20 to DN 80) be soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) wrought-copper, solder-joint fittings; and brazed joints.

F. Underground water-service piping NPS 4 and NPS 6 (DN 100 and DN 150) shall be any of the following:
   1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) wrought-copper, solder-joint fittings; and brazed joints.
   2. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed or mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.
   3. NPS 4 and NPS 6 (DN 100 and DN 150): NPS 6 (DN 150) PVC, AWWA Class 150 pipe; PVC, AWWA Class 150 molded fittings; and gasketed joints.

G. Water Meter Box Water-Service Piping NPS 3/4 to NPS 2 (DN 20 to DN 50) be same as underground water-service piping.

3.3 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for NPS 3 (DN 80) and larger underground installation. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 (DN 50) and smaller installation.

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Underground Valves, NPS 3 (DN 80) and Larger: AWWA, cast-iron, nonrising-stem, resilient seated gate valves with valve box.

3.4 PIPING INSTALLATION

A. Water-Main Connection: Arrange with utility company for tap of size and in location indicated in water main.

B. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.

C. Make connections larger than NPS 2 (DN 50) with tapping machine according to the following:
   1. Install tapping sleeve and tapping valve according to MSS SP-60.
2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.

D. Make connections NPS 2 (DN 50) and smaller with drilling machine according to the following:
    1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
    2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
    3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
    4. Install corporation valves into service-saddle assemblies.
    5. Install manifold for multiple taps in water main.
    6. Install curb valve in water-service piping with head pointing up and with service box.

E. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

F. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.

G. Bury piping with depth of cover over top at least 30 inches (750 mm) with top at least 12 inches (300 mm) below level of maximum frost penetration.

H. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
    1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.

I. Sleeves are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

J. Mechanical sleeve seals are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

K. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

3.5 JOINT CONSTRUCTION

A. Make pipe joints according to the following:
3. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.

4. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

3.6 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
   1. Concrete thrust blocks.
   2. Locking mechanical joints.
   4. Bolted flanged joints.
   5. Heat-fused joints.
   6. Pipe clamps and tie rods.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
   2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.7 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

3.8 WATER METER INSTALLATION

A. Install water meters, piping, and specialties according to utility company's written instructions.

B. Water Meters: Install displacement-type water meters, NPS 2 (DN 50) and smaller, in meter boxes with shutoff valves on water meter inlets. Include valves on water meter outlets and valved bypass around meters unless prohibited by authorities having jurisdiction.

C. Water Meters: Install compound-type water meters, NPS 3 (DN 80) and larger, in meter vaults. Include shutoff valves on water meter inlets and outlets and valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.
3.9 WATER METER BOX INSTALLATION
   A. Install water meter boxes in paved areas flush with surface.
   B. Install water meter boxes in grass or earth areas with top 2 inches (50 mm) above surface.

3.10 CONCRETE VAULT INSTALLATION
   A. Install precast concrete vaults according to ASTM C 891.

3.11 CONNECTIONS
   A. Connect water-distribution piping to existing water main.
   B. Connect water-distribution piping to interior domestic water piping.

3.12 FIELD QUALITY CONTROL
   A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
   B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.
      1. Increase pressure in 50-psig (350-kPa) increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig (0 kPa). Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts (1.89 L) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.
   C. Prepare reports of testing activities.

3.13 IDENTIFICATION
   A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."
   B. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Section 330500 "Common Work Results for Utilities" for identifying devices.

3.14 CLEANING
   A. Clean and disinfect water-distribution piping as follows:
1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.

2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.

3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

   a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
   
   b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
   
   c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
   
   d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 221113
SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.

B. Related Requirements:

1. Section 221113 "Facility Water Distribution Piping" for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

1.2 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

1.3 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."
2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) water tube, annealed temper.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.


E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Copper Unions:
   1. MSS SP-123.
   4. Solder-joint or threaded ends.

G. Copper Pressure-Seal-Joint Fittings:
   1. Fittings for NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
   2. Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

2.3 PIPING JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, lead-free alloys.

B. Flux: ASTM B 813, water flushable.

C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 TRANSITION FITTINGS

A. General Requirements:
   1. Same size as pipes to be joined.
   2. Pressure rating at least equal to pipes to be joined.
   3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

   a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
   b. Central Plastics Company.
   d. Jomar International.
   e. Matco-Norca.
   g. Watts; a division of Watts Water Technologies, Inc.
   h. Wilkins; a Zurn company.


4. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).

5. End Connections: Solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with
requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."

D. Install shutoff valve immediately upstream of each dielectric fitting.

E. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

F. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

G. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

I. Install piping to permit valve servicing.

J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

K. Install piping free of sags and bends.

L. Install fittings for changes in direction and branch connections.

M. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

N. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."

O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."
3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

D. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

F. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges, flange kits, and nipples.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.

2. Individual, Straight, Horizontal Piping Runs:

   a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.

   b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support vertical piping and tubing at base.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

   1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.

F. Install supports for vertical copper tubing every 10 feet (3 m).

G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

   1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
3.8 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:
   a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
      2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
   c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
   d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:
   a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
   c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   d. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
   f. Prepare reports for tests and for corrective action required.
B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
   a. Adjust calibrated balancing valves to flows indicated.
4. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
6. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge piping before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
   b. Fill and isolate system according to either of the following:
      1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
      2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
   c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
   d. Repeat procedures if biological examination shows contamination.
   e. Submit water samples in sterile bottles to authorities having jurisdiction.
B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Under-building-slab, domestic water, building-service piping, NPS 3 (DN 80) and smaller, shall be the following:
   1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.

D. Aboveground domestic water piping, shall be one of the following:
   1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast- or wrought-copper, solder-joint fittings; and brazed or soldered joints.
   2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.

END OF SECTION 22 11 16
SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Vacuum breakers.
   2. Backflow preventers.
   3. Temperature-actuated, water mixing valves.
   4. Strainers.
   5. Hose bibbs.
   6. Wall hydrants.
   7. Drain valves.
   8. Water-hammer arresters.

B. Related Requirements:
   1. Section 220519 "Meters and Gages for Plumbing Piping" for thermometers, and pressure gages.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61 and NSF 14.
2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa) unless otherwise indicated.

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
   2. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.
   4. Inlet and Outlet Connections: Threaded.
   5. Finish: Rough bronze.

B. Hose-Connection Vacuum Breakers:
   2. Body: Bronze, nonremovable, with manual drain.
   4. Finish: Chrome or nickel plated.

2.4 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:
   2. Operation: Continuous-pressure applications.
   3. Pressure Loss: 12 psig (83 kPa) maximum, through middle third of flow range.
   4. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 (DN 65) and larger.
   5. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
   6. Configuration: Designed for horizontal, straight-through, vertical flow.
   7. Accessories:
      a. Valves: Ball type with threaded ends on inlet and outlet.

2.5 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

   b. Cash Acme; a division of Reliance Worldwide Corporation.
   c. Conbraco Industries, Inc.
   d. Honeywell International Inc.
   e. Legend Valve.
   f. Leonard Valve Company.
   g. Powers; a division of Watts Water Technologies, Inc.
   h. Symmons Industries, Inc.
   i. TACO Incorporated.
   j. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   k. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

5. Type: Thermostatically controlled, water mixing valve.
7. Connections: Threaded inlets and outlet.
8. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
10. Valve Finish: Chrome plated.

2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 (DN 65) and larger.
3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:

   a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm).
   b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch (1.14 mm).

6. Drain: Pipe plug or factory-installed, hose-end drain valve.
2.7 HOSE BIBBS

A. Hose Bibbs:
   4. Supply Connections: NPS 1/2 or NPS 3/4 (DN 15 or DN 20) threaded or solder-joint inlet.
   5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
   8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
   9. Finish for Service Areas: Chrome or nickel plated.
   10. Finish for Finished Rooms: Chrome or nickel plated.
   11. Operation for Equipment Rooms: Wheel handle or operating key.
   12. Operation for Service Areas: Operating key.
   14. Include operating key with each operating-key hose bibb.
   15. Include wall flange with each chrome- or nickel-plated hose bibb.

2.8 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:
   3. Operation: Loose key.
   4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
   5. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).
   7. Operating Keys(s): Two with each wall hydrant.

2.9 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
   2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
   4. Body: Copper alloy.
   5. Ball: Chrome-plated brass.
   8. Inlet: Threaded or solder joint.

2.10 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

a. AMTROL, Inc.
b. Josam Company.
c. MIFAB, Inc.
d. Precision Plumbing Products, Inc.
e. Sioux Chief Manufacturing Company, Inc.
g. Tyler Pipe; Wade Div.
h. Watts Drainage Products.
i. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.

4. Type: Metal bellows or copper tube with piston.
5. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.11 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

a. MIFAB, Inc.
b. Precision Plumbing Products, Inc.
c. Sioux Chief Manufacturing Company, Inc.
e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

4. Pressure Rating: 125 psig (860 kPa) minimum.
5. Body: Bronze.
6. Inlet and Outlet Connections: NPS 1/2 (DN 15) threaded, union, or solder joint.
7. Gravity Drain Outlet Connection: NPS 1/2 (DN 15) threaded or solder joint.
8. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Inspect valves for signs of foreign matter or corrosion.
   B. Do not attempt to repair defective valves; replace with new valves.
   C. Examine connection surfaces for conditions that may cause leakage after installation. Verify bolt and gasket sizes and material composition.

3.2 INSTALLATION
   A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
      1. Locate backflow preventers in same room as connected equipment or system.
      2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
      3. Do not install bypass piping around backflow preventers.
   B. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
   C. Install Y-pattern strainers for water on supply side of each control valve and water pressure-reducing valve.
   D. Install water-hammer arresters in water piping according to PDI-WH 201.
   E. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

3.3 FIELD QUALITY CONTROL
   A. Perform the following tests and inspections:
1. Test each pressure vacuum breaker and reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 22 11 19
SECTION 221313 - FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Pipe and fittings.
   2. Nonpressure and pressure couplings.
   3. Expansion joints.
   5. Encasement for piping.

1.2 ACTION SUBMITTALS
A. Product Data: For expansion joints.
B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.3 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS
A. PVC Type PSM Sewer Piping:
   1. Pipe: ASTM D 3034, SDR 35 PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
   2. Fittings: ASTM D 3034, PVC with bell ends.
2.2 CLEANOUTS

A. Cast-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.

1. Top-Loading Classification(s): Light Duty, Medium Duty, Heavy Duty and Extra-Heavy Duty.
2. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

2.3 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105.

2.4 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
4. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (100-mm) minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
5. Riser Sections: 4-inch (100-mm) minimum thickness, of length to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
8. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm)
10. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:
1. Description: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser, with 4-inch- (100-mm-) minimum-width flange and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."

2. Material: ASTM A 536, Grade 60-40-18 ductile iron unless otherwise indicated.

2.5 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R (ACI 350M/350RM), and the following:
   1. Cement: ASTM C 150, Type II.

B. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.
   2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
   1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
      a. Invert Slope: 2 percent through manhole.
   2. Benches: Concrete, sloped to drain into channel.
      a. Slope: 8 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water/cementitious materials ratio.
   2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."
3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure, drainage piping according to the following:
   1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
   2. Install piping NPS 6 (DN 150) and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
   3. Install piping with 36-inch (915-mm) minimum cover.
   5. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
   6. Install PVC corrugated sewer piping according to ASTM D 2321.
   7. Install PVC Type PSM sewer piping according to ASTM D 2321.
   8. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
   9. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping according to the following:
   1. Join PVC corrugated sewer piping according to ASTM D 2321.
2. Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
3. Join dissimilar pipe materials with nonpressure-type, flexible or rigid couplings.

B. Pipe couplings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
   1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
      a. Unshielded flexible couplings for pipes of same or slightly different OD.
      b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
      c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.4 MANHOLE INSTALLATION
   A. General: Install manholes complete with appurtenances and accessories indicated.
   B. Install precast concrete manhole sections with sealants according to ASTM C 891.
   C. Install FRP manholes according to manufacturer's written instructions.
   D. Form continuous concrete channels and benches between inlets and outlet.
   E. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere unless otherwise indicated.
   F. Install manhole-cover inserts in frame and immediately below cover.

3.5 CONCRETE PLACEMENT
   A. Place cast-in-place concrete according to ACI 318.

3.6 CLEANOUT INSTALLATION
   A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use PVC pipe fittings in sewer pipes at branches for cleanouts, and use PVC pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
      1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
      2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
      3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set with tops 1 inch (25 mm) above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.7 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 221316 "Sanitary Waste and Vent Piping."

B. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch (150-mm) overlap with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).

2. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).

3. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.

   a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20.7 MPa) unless otherwise indicated.

   b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

C. Connect to grease, oil and sand interceptors specified in Section 221323 "Sanitary Waste Interceptors."

3.8 IDENTIFICATION

A. Materials and their installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.9 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:
   a. Alignment: Less than full diameter of inside of pipe is visible between structures.
   b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
   c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
   d. Infiltration: Water leakage into piping.
   e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
   a. Fill sewer piping with water. Test with pressure of at least 10-foot (3-m) head of water, and maintain such pressure without leakage for at least 15 minutes.
   b. Close openings in system and fill with water.
   c. Purge air and refill with water.
   d. Disconnect water supply.
   e. Test and inspect joints for leaks.

6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
   a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
   b. Option: Test concrete gravity sewer piping according to ASTM C 924 (ASTM C 924M).
7. Manholes: Perform hydraulic test according to ASTM C 969 (ASTM C 969M).

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.10 CLEANING

A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION 221313
SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe, tube, and fittings.
   2. Specialty pipe fittings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
   2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

1.3 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.

C. CISPI, Hubless-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. ANACO-Husky.
c. Fernco Inc.
d. MIFAB, Inc.
e. Mission Rubber Company; a division of MCP Industries, Inc.
f. Tyler Pipe.

3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.2 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following or available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

      2) Fernco Inc.
      3) Mission Rubber Company; a division of MCP Industries, Inc.

   c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
   d. Sleeve Materials:

      2) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."
3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping free of sags and bends.

F. Install fittings for changes in direction and branch connections.

G. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

H. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

I. Install soil and waste drainage and vent piping at the following minimum slopes per Plumbing Code.


K. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
L. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

M. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

N. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

O. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, nonpressure transition couplings.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42, clamps.
4. Install individual, straight, horizontal piping runs:

   a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.

5. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

B. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting and coupling.
C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
4. Spacing for 10-foot (3-m) lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).

F. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
3. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
4. Comply with requirements for cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."
3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer. Inspect plumbing fixture connections for gas and water leaks per local inspection guidelines.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.9 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.
3.10 PIPING SCHEDULE

A. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller shall be any of the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.

B. Aboveground, vent piping shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.

C. Underground, soil, waste, and vent piping shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.

END OF SECTION 22 13 16
SECTION 22 13 16 - STORM, SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Pipe, tube, and fittings.
   2. Specialty pipe fittings.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

1.3 QUALITY ASSURANCE
A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS
A. Pipe and Fittings: ASTM A 888 or CISPI 301.
B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.
C. CISPI, Hubless-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. ANACO-Husky.
      c. Fernco Inc.
      d. MIFAB, Inc.
      e. Mission Rubber Company; a division of MCP Industries, Inc.
      f. Tyler Pipe.
   3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
2.2 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.

2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

3. Unshielded, Nonpressure Transition Couplings:

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following or available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

      2) Fernco Inc.
      3) Mission Rubber Company; a division of MCP Industries, Inc.


   c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

   d. Sleeve Materials:

      2) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping free of sags and bends.

F. Install fittings for changes in direction and branch connections.

G. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

H. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

I. Install soil and waste drainage and vent piping at the following minimum slopes per Plumbing Code.


K. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."

L. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

M. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

N. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
O. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, nonpressure transition couplings.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42, clamps.
4. Install individual, straight, horizontal piping runs:
   a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
5. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

B. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
4. Spacing for 10-foot (3-m) lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).

F. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:
   1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
   2. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
   3. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
   4. Comply with requirements for cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer. Inspect plumbing fixture connections for gas and water leaks per local inspection guidelines.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.9 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.10 PIPING SCHEDULE

A. Aboveground, storm, soil and waste piping shall be the following:

1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.

B. Aboveground, vent piping shall be the following:
1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.


C. Underground, soil, waste, and vent piping shall be the following:

1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.

END OF SECTION 22 13 16
SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:

1. Cleanouts.
2. Floor drains.

1.2 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A.Exposed Cast-Iron Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.

4. Size: Same as connected drainage piping
5. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
6. Closure: Countersunk or raised-head, cast-iron plug.
7. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Floor Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
   b. Oatey.
   c. Sioux Chief Manufacturing Company, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products Inc.
   g. Zurn Plumbing Products Group; Light Commercial Operation.
   h. Zurn Plumbing Products Group; Specification Drainage Operation.


4. Size: Same as connected branch.

5. Type: Threaded, adjustable housing.

6. Body or Ferrule: Cast iron.

7. Closure: Brass plug with tapered threads.

8. Adjustable Housing Material: Cast iron with threads or set-screws or other device.


10. Top Loading Classification: Medium Duty.

11. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.

3. Standard: ASME A112.36.2M. Include wall access.

4. Size: Same as connected drainage piping.

5. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

   a. Commercial Enameling Co.
   b. Josam Company; Josam Div.
   c. MIFAB, Inc.
   d. Prier Products, Inc.
   e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   f. Tyler Pipe; Wade Div.
   g. Watts Drainage Products Inc.
   h. Zurn Plumbing Products Group; Light Commercial Operation.
   i. Zurn Plumbing Products Group; Specification Drainage Operation.


5. Outlet: Bottom.


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2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

   a. Acorn Engineering Company; Elmdor/Stoneman Div.
   b. Thaler Metal Industries Ltd.

B. Description: Manufactured assembly made of 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch-(1.6-mm-) thick, lead flashing collar and skirt extending at least 10 inches (250 mm) from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.


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2.4 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft. (15-kg/sq. m), 0.0469-inch (1.2-mm) thickness.
3. Burning: 6-lb/sq. ft. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness.

B. Fasteners: Metal compatible with material and substrate being fastened.

C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

D. Solder: ASTM B 32, lead-free alloy.

E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

   a. Radius, 30 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
   b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
   c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) total depression.
3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

5. Install trap-seal protection devices in floor drains during trim out stage of project.

E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

F. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

   1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
   2. Size: Same as floor drain inlet.

G. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

A. Secure flashing into sleeve and specialty clamping ring or device.

B. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 076200 "Sheet Metal Flashing and Trim."

C. Extend flashing up vent pipe passing through roofs and turn down into pipe.

END OF SECTION 22 13 19
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipes, tubes, and fittings.
   2. Piping specialties.
   3. Piping and tubing joining materials.
   5. Pressure regulators.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of seismic restraints.
   2. Design Calculations: Calculate requirements for selecting seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:
   1. Piping and Valves: 100 psig (690 kPa) minimum unless otherwise indicated.
   2. Service Regulators: 65 psig (450 kPa) minimum unless otherwise indicated.

B. Natural-Gas System Pressure within Buildings: 0.5 psig (3.45 kPa) or less.

C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

2.2 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

2.3 PIPING SPECIALTIES

A. Appliance Flexible Connectors:
   3. Corrugated stainless-steel tubing with polymer coating.
   4. Operating-Pressure Rating: 0.5 psig (3.45 kPa).
   5. End Fittings: Zinc-coated steel.
   7. Maximum Length: 72 inches (1830 mm.)

2.4 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

2.5 MANUAL GAS SHUTOFF VALVES

A. See "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig (862 kPa).
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
6. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. A.Y. McDonald Mfg. Co.
   b. Apollo Flow Controls; Conbraco Industries, Inc.
   c. BrassCraft Manufacturing Co.; a Masco company.
   d. Lyall, R. W. & Company, Inc.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
8. CWP Rating: 600 psig (4140 kPa).
9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Bronze Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. A.Y. McDonald Mfg. Co.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig (862 kPa).
7. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.6 PRESSURE REGULATORS

A. General Requirements:
   1. Single stage and suitable for natural gas.
   2. Steel jacket and corrosion-resistant components.
   3. Elevation compensator.
   4. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Actaris.
      b. American Meter Company.
      c. Eclipse Innovative Thermal Technologies.
      d. Fisher Control Valves & Instruments; a brand of Emerson Process Management.
      e. Invensys.
      f. Itron Gas.
      g. Maxitrol Company.
   2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
   5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
   6. Orifice: Aluminum; interchangeable.
   8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
   9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
   11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
   12. Maximum Inlet Pressure: 2 psig (13.8 kPa).

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Canadian Meter Company Inc.
   b. Eaton.
   c. Harper Wyman Co.
   d. Maxitrol Company.


5. Seat Disc: Nitrile rubber.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

PART 3 - EXECUTION

3.1 OUTDOOR PIPING INSTALLATION
   B. Install fittings for changes in direction and branch connections.

3.2 INDOOR PIPING INSTALLATION
   B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
   C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
   D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
   E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

Q. Connect branch piping from top or side of horizontal piping.

R. Install unions in pipes, adjacent to each valve, at final connection to each piece of equipment.

S. Do not use natural-gas piping as grounding electrode.

T. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

U. Install pressure gage downstream from each line regulator.

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 VALVE INSTALLATION
A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing or copper connector.
B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

3.4 PIPING JOINT CONSTRUCTION
A. Ream ends of pipes and tubes and remove burrs.
B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Threaded Joints:
   1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
   2. Cut threads full and clean using sharp dies.
   3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
   4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
   5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
D. Welded Joints:
   2. Bevel plain ends of steel pipe.
   3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.5 HANGER AND SUPPORT INSTALLATION
A. Comply with requirements for pipe hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).
2. NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).

3.6 CONNECTIONS
   A. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
   B. Install piping adjacent to appliances to allow service and maintenance of appliances.
   C. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
   D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.7 FIELD QUALITY CONTROL
   A. Test, inspect, and purge natural gas according to NFPA 54 and the International Fuel Gas Code and authorities having jurisdiction.
   B. Natural-gas piping will be considered defective if it does not pass tests and inspections.
   C. Prepare test and inspection reports.

3.8 OUTDOOR PIPING SCHEDULE
   A. Aboveground natural-gas piping shall be one of the following:
      1. Steel pipe with malleable-iron fittings and threaded joints.
      2. Steel pipe with wrought-steel fittings and welded joints.

3.9 INDOOR PIPING SCHEDULE
   A. Aboveground, branch piping shall be the following:
      1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
      2. Steel pipe with malleable-iron fittings and threaded joints.
   B. Aboveground, distribution piping shall be one of the following:
      1. Steel pipe with malleable-iron fittings and threaded joints.
      2. Steel pipe with wrought-steel fittings and welded joints.
3.10 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves shall be one of the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze plug valve.

B. Valves in branch piping for single appliance shall be one of the following:
   1. One-piece, bronze ball valve with bronze trim.
   2. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION 22 16 13
SECTION 22 34 00 - FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Power-vent, gas-fired, storage, domestic-water heaters.
   2. Domestic-water heater accessories.

1.2 ACTION SUBMITTALS
A. Product Data: For each type and size of domestic-water heater indicated.
B. LEED Submittals:
   1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1, Section 7, "Service Water Heating."
C. Shop Drawings:
   1. Manufacturers submittal drawings.

1.3 INFORMATIONAL SUBMITTALS
A. Product certificates.
B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

1.4 CLOSEOUT SUBMITTALS
A. Operation and maintenance data.

1.5 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.
C. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Warranty Periods: From date of Substantial Completion.
   a. Commercial, Gas-Fired, Domestic-Water Heaters:
      1) Controls and Other Components: Two year(s).
   b. Gas-Fired, Storage, Domestic-Water Heaters:
      1) Storage Tank: Five years.
      2) Controls and Other Components: Three years.
   c. Compression Tanks: Five years.
   d. Contractor to assume responsibility for warranty in instances where manufacturer’s warranty is inadequate.

PART 2 - PRODUCTS

2.1 GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

A. Power-Vent, Gas-Fired, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings.
   b. Lochinvar Corporation.
   c. Rheem Manufacturing Company.
   d. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
   e. State Industries.

b. Pressure Rating: 150 psig (1035 kPa).
c. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining material into tappings.

5. Factory-Installed Storage-Tank Appurtenances:
   a. Anode Rod: Replaceable magnesium.
   b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
   c. Drain Valve: ASSE 1005.
   d. Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2.
   e. Jacket: Steel with enameled finish.
   f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
   g. Burner: For use with power-vent, gas-fired, domestic-water heaters and natural-gas fuel.
   h. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, electric, automatic, gas-ignition system.
   i. Temperature Control: Adjustable thermostat.
   j. Combination Temperature-and-Pressure Relief Valve: ANSI Z21.22/CSA 4.4-M. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.


B. Capacity and Characteristics:
   1. Capacity: Per equipment data.
   2. Recovery: Per equipment data.
   3. Temperature Setting: 145 deg F (63 deg C).
   4. Gas Pressure Regulator:
   5. Electrical Characteristics:
      a. Volts: 120.
      b. Phase: Single.
      c. Hertz: 60.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
a. AMTROL Inc.
b. Flexcon Industries.
c. Honeywell International Inc.
d. Pentair Pump Group (The); Myers.
e. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
f. State Industries.
g. Taco, Inc.
h. Watts.

3. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.

4. Construction:
   a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
   b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Air-Charging Valve: Factory installed.

5. Capacity and Characteristics:
   a. Working-Pressure Rating: 150 psig (1035 kPa).


C. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

2.3 SOURCE QUALITY CONTROL

A. Hydrostatically test domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.
PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Domestic-Water Heater Mounting: Install domestic-water heater on pan.

B. Domestic-Water Heater Mounting: Install domestic-water heaters on floor.
   1. Maintain manufacturer's recommended clearances.
   2. Arrange units so controls and devices that require servicing are accessible.

C. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
   1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."

D. Install gas-fired, domestic-water heaters according to NFPA 54.
   1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
   2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
   3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.

E. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

F. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

G. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

H. Fill domestic-water heaters with water.

I. Charge domestic-water compression tanks with air.
3.2 CONNECTIONS
   A. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."
   B. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 IDENTIFICATION
   A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL
   A. Perform tests and inspections.
      1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
      2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
      3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
   C. Prepare test and inspection reports.

END OF SECTION 22 34 00
SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Provide plumbing fixtures and trim, fittings, and accessories, appliances, appurtenances, equipment, and supports associated with plumbing fixtures.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
   1. Product Data for Prerequisite WE 1 and Credit WE 3, Credit WE 2, and Credit WE 3: Documentation indicating flow and water consumption requirements.
   2. Product Data for Prerequisite WE 1: Documentation indicating flow and water consumption requirements.
   3. Product Data for Prerequisite WE 1 and Credit WE 2: Documentation indicating flow and water consumption requirements.

C. Shop Drawings: Include diagrams for power, signal, and control wiring.

PART 2 - PRODUCTS

2.1 FIXTURES BY OTHERS

A. Provide plumbing fixtures and trim, fittings, other components, and supports as specified in Plumbing Fixture Data Sheets at the end of this section, Drawing Schedules.

B. All plumbing trim, fitting, supply piping and other components to be chrome finish where exposed to view, unless otherwise noted.

PART 3 - EXECUTION

3.1 APPLICATION

A. Install supports for plumbing fixtures in accordance with categories indicated, and of type required.
   1. Foot support carrier for the following fixtures:
a. Water closets.

2. Chair carrier for the following fixtures:
   a. Wall hung lavatories.
   b. Urinals.
   c. Electric water coolers.

3. Chair carrier support base shall fit in a standard 2” x 4” stud wall.

3.2 ADJUSTING AND CLEANING

   A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

   B. Adjust water temperature to 110 degrees F at accessible fixture outlet(s) and 115 degrees F at all other hand sinks, lavatories, showers and etc.

   C. Clean fixtures, fittings, spout aerators, and drain strainers with manufacturers' recommended cleaning methods and materials.

END OF SECTION 22 40 00
SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.
D. Multispeed Motors: Variable torque.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.


F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F

I. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.
   2. Split phase.
   3. Capacitor start, inductor run.
   4. Capacitor start, capacitor run.
B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 23 05 13
SECTION 23 05 14 - VARIABLE-FREQUENCY DRIVE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes separately enclosed, preassembled, combination VFDs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.2 DEFINITIONS

A. CE: Conformite Europeeene (European Compliance).
B. CPT: Control power transformer.
C. DDC: Direct digital control.
D. EMI: Electromagnetic interference.
E. OCPD: Overcurrent protective device.
F. PID: Control action, proportional plus integral plus derivative.
G. RFI: Radio-frequency interference.
H. VFD: Variable-frequency drive.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFD indicated.
B. Shop Drawings: For each VFD indicated.
   1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.
B. Product certificates.
C. Field quality-control reports.
1.5 CLOSEOUT SUBMITTALS
   A. Operation and maintenance data.

1.6 QUALITY ASSURANCE
   A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1.7 WARRANTY
   A. Special Warranty: Manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.
      1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. ABB Low Voltage HVAC Drives.
      2. Eaton.
      3. Yaskawa Electric America, Inc.
      4. Square D

2.2 SYSTEM DESCRIPTION
   A. General Requirements for VFDs:
      1. VFDs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
      2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.
   B. Application: Variable torque.
   C. VFD Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
      1. Units suitable for operation of NEMA MG 1 motors.
      2. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

F. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFD input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 3 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFD frequency rating.
4. Minimum Efficiency: 97 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: 100 kA.
7. Ambient Temperature Rating: Not less than 32 deg F (0 deg C) and not exceeding 104 deg F (40 deg C).
8. Humidity Rating: Less than 95 percent (noncondensing).
9. Altitude Rating: Not exceeding 3300 feet (1000 m).
11. Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
13. Speed Regulation: Plus or minus 5 percent.
14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

H. Isolated Control Interface: Allows VFDs to follow remote-control signal over a minimum 40:1 speed range.


I. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

J. Self-Protection and Reliability Features:

1. Surge Suppression: Factory installed as an integral part of the VFD, complying with UL 1449 SPD, Type 1 or Type 2.
3. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
5. Inverter overcurrent trips.
6. VFD and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
7. Critical frequency rejection, with three selectable, adjustable deadbands.
8. Instantaneous line-to-line and line-to-ground overcurrent trips.
11. Short-circuit protection.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

M. Bidirectional Autospeed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

P. Integral Input Disconnecting Means and OCPD: UL 489, molded-case switch, with power fuse block and current-limiting fuses or UL 489, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115 percent of VFD input current rating.
2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.
3. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
5. NO alarm contact that operates only when circuit breaker has tripped.

2.3 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least one level of access: View only; view and operate; and view, operate, and service.
   a. Control Authority: Supports at least four conditions: Off, local manual control at VFD, local automatic control at VFD, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFD door and connected to display VFD parameters including, but not limited to:

1. Output frequency (Hz).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:
   a. A minimum of two programmable analog inputs: 4- to 20-mA dc.
   b. A minimum of six multifunction programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:
   a. 0- to 10-V dc.
b. 4- to 20-mA dc.
c. Potentiometer using up/down digital inputs.
d. Fixed frequencies using digital inputs.

3. Output Signal Interface: A minimum of one programmable analog output signal(s) (4- to 20-mA dc), which can be configured for any of the following:

a. Output frequency (Hz).
b. Output current (load).
c. DC-link voltage (V dc).
d. Motor torque (percent).
e. Motor speed (rpm).
f. Set point frequency (Hz).

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: Two.

2.4 BYPASS SYSTEMS

A. Bypass Operation: Manually transfers motor between power converter output and bypass circuit. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. Bypass Mode: Manual operation only; requires local operator selection at VFD. Transfer between power converter and bypass contactor, and retransfer shall only be allowed with the motor at zero speed.

C. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

2. Output Isolating Contactor: Non-load-break, NEMA-rated contactor.
3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

D. Bypass Contactor Configuration: Reduced-voltage (autotransformer) type.

1. NORMAL/BYPASS selector switch.
2. HAND/OFF/AUTO selector switch.
3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFD while the motor is running in the bypass mode.
a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with control power source of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
   a. CPT Spare Capacity: 100 VA.


2.5 OPTIONAL FEATURES

A. Damper control circuit with end-of-travel feedback capability.

B. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

2.6 ENCLOSURES

A. VFD Enclosures: NEMA 250, to comply with environmental conditions at installed location.
   1. Dry and Clean Indoor Locations: Type 1.
   2. Outdoor Locations: Type 4X.
   3. Other Wet or Damp Indoor Locations: Type 4.
   4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFD as "Plenum Rated."

2.7 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFD enclosure cover unless otherwise indicated.

B. NO bypass contactor auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.


E. Supplemental Digital Meters:

1. Elapsed-time meter.
2. Kilowatt meter.

F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches (2000 mm) above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

B. Roof-Mounting Controllers: Install VFD on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches (2000 mm) above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.

1. Curbs and roof penetrations are specified in Section 077200 "Roof Accessories."
2. Structural-steel channels are specified in Section 260529 "Hangers and Supports for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in each fusible-switch VFD.

E. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.

F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
G. Comply with NECA 1.

3.2 CONTROL WIRING INSTALLATION

A. Install wiring between VFDs and remote devices and facility's central-control system.

B. Bundle, train, and support wiring in enclosures.

3.3 IDENTIFICATION

A. Identify VFDs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFD with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Inspect VFD, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).
5. Test each motor for proper phase rotation.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
D. VFDs will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies the VFD and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.5 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges.

F. Set field-adjustable pressure switches.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFDs.

END OF SECTION 23 04 14
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Bimetallic-actuated thermometers.
   2. Liquid-in-glass thermometers.
   3. Thermowells.
   4. Dial-type pressure gages.
   5. Gage attachments.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. Wiring Diagrams: For power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

B. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch (127-mm) nominal diameter.
C. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F (deg C).
D. Connector Type(s): Union joint, rigid, back and rigid, bottom, with unified-inch screw threads.
E. Connector Size: 1/2 inch (13 mm), with ASME B1.1 screw threads.
F. Stem: 0.25 or 0.375 inch (6.4 or 9.4 mm) in diameter; stainless steel.
G. Window: Plain glass.

H. Ring: Stainless steel.

I. Element: Bimetal coil.

J. Pointer: Dark-colored metal.

K. Accuracy: Plus or minus 1 percent of scale range.

2.2 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
   2. Case: Cast aluminum; 9-inch (229-mm) nominal size unless otherwise indicated.
   3. Case Form: Back angle unless otherwise indicated.
   4. Tube: Glass with magnifying lens and blue or red organic liquid.
   5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
   7. Stem: Aluminum and of length to suit installation.
      b. Design for Thermowell Installation: Bare stem.
   9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 DUCT-THERMOMETER MOUNTING BRACKETS

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.4 THERMOWELLS

A. Thermowells:
   2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
   3. Material for Use with Copper Tubing: CNR or CUNI.
   4. Material for Use with Steel Piping: CRES.
   5. Type: Stepped shank unless straight or tapered shank is indicated.
   6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
   7. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell’s internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.5 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
2. Case: Liquid-filled Sealed type; cast aluminum or drawn steel; 6-inch (152-mm) nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
8. Window: Glass
9. Ring: Metal
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.6 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of brass or stainless-steel pipe with NPS 1/4 or NPS 1/2 (DN 8 or DN 15) pipe threads.

C. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
C. Install thermowells with extension on insulated piping.
D. Fill thermowells with heat-transfer medium.
E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
I. Install remote-mounted pressure gages on panel.
J. Install valve and snubber in piping for each pressure gage for fluids (except steam).
K. Install valve and syphon fitting in piping for each pressure gage for steam.
L. Install flow indicators in piping systems in accessible positions for easy viewing.
M. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
N. Install flowmeter elements in accessible positions in piping systems.
O. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
P. Install permanent indicators on walls or brackets in accessible and readable positions.
Q. Install connection fittings in accessible locations for attachment to portable indicators.
R. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
S. Install thermometers in the following locations:
   1. Inlet and outlet of each hydronic zone.
   2. Inlet and outlet of each hydronic boiler.
   3. Inlet and outlet of each hydronic coil in air-handling units.
   4. Outside-, return-, supply-, and mixed-air ducts.
T. Install pressure gages in the following locations:
   1. Discharge of each pressure-reducing valve.
   2. Suction and discharge of each pump.
3.2 CONNECTIONS
   A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
   B. Connect flowmeter-system elements to meters.
   C. Connect flowmeter transmitters to meters.
   D. Connect thermal-energy meter transmitters to meters.

3.3 ADJUSTING
   A. After installation, calibrate meters according to manufacturer's written instructions.
   B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE
   A. Thermometers at inlet and outlet of each hydronic zone shall be one of the following:
      1. Liquid-filled, bimetallic-actuated type.
      2. Industrial-style, liquid-in-glass type.
   B. Thermometers at inlet and outlet of each hydronic boiler shall be one of the following:
      1. Liquid-filled, bimetallic-actuated type.
      2. Industrial-style, liquid-in-glass type.
   C. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one of the following:
      1. Sealed bimetallic-actuated type.
      2. Industrial-style, liquid-in-glass type.
   D. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be one of the following:
      1. Liquid-filled, bimetallic-actuated type.
      2. Industrial-style, liquid-in-glass type.
   E. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE
   A. Scale Range for Heating, Hot-Water Piping: 0 to 250 deg F (0 to 150 deg C)
   B. Scale Range for Air Ducts: 0 to 100 deg F (Minus 20 to plus 50 deg C)
3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each pressure-reducing valve shall be one of the following:

1. Sealed, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.

B. Pressure gages at suction and discharge of each pump shall be one of the following:

1. Sealed direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi (0 to 600 kPa).

END OF SECTION 23 05 19
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Brass ball valves.
   2. Bronze ball valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B1.20.1 for threads for threaded-end valves.
   2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   4. ASME B31.1 for power piping valves.
   5. ASME B31.9 for building services piping valves.

C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

D. Refer to HVAC valve schedule articles for applications of valves.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 4 (DN 100) and larger.
   2. Handlever: For quarter-turn valves smaller than NPS 4 (DN 100)
H. Valves in Insulated Piping:
   1. Include 2-inch (50-mm) stem extensions.
   2. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
   3. Memory stops that are fully adjustable after insulation is applied.

I. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

A. One-Piece Brass Ball Valves:
   1. Description:
      b. CWP Rating: 400 psig (2760 kPa).
      c. Body Design: One piece.
      d. Body Material: Forged brass.
      e. Ends: Threaded.
      f. Seats: PTFE.
      g. Stem: Brass.
      h. Ball: Chrome-plated brass.
      i. Port: Reduced.

2.3 BRONZE BALL VALVES

A. One-Piece Bronze Ball Valves with Bronze Trim:
   1. Description:
      b. CWP Rating: 400 psig (2760 kPa).
      c. Body Design: One piece.
      d. Body Material: Bronze.
      e. Ends: Threaded.
      f. Seats: PTFE.
      g. Stem: Bronze.
      h. Ball: Chrome-plated brass.
      i. Port: Reduced.

B. One-Piece Bronze Ball Valves with Stainless-Steel Trim:
   1. Description:
      b. CWP Rating: 600 psig (4140 kPa).
      c. Body Design: One piece.
d. Body Material: Bronze.
e. Ends: Threaded.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel, vented.
i. Port: Reduced.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION
A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
B. Locate valves for easy access and provide separate support where necessary.
C. Install valves in horizontal piping with stem at or above center of pipe.
D. Install valves in position to allow full stem movement.

3.2 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS
A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
B. Select valves with the following end connections:
   1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
   2. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.

3.3 HEATING-WATER VALVE SCHEDULE
A. Pipe NPS 2 (DN 50) and Smaller: One piece, full port, brass or bronze with stainless-steel trim.
   1. Valves may be provided with solder-joint ends instead of threaded ends.

END OF SECTION 23 05 23.12
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Bronze lift check valves.
   2. Bronze swing check valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B1.20.1 for threads for threaded-end valves.
   2. ASME B16.1 for flanges on iron valves.
   3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   4. ASME B16.18 for solder joint.
   5. ASME B31.1 for power piping valves.
   6. ASME B31.9 for building services piping valves.

C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Bypass and Drain Connections: MSS SP-45.
2.2 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:
   1. Description:
      a. Standard: MSS SP-80, Type 3.
      b. CWP Rating: 200 psig (1380 kPa).
      c. Body Design: Horizontal flow.
      e. Ends: Threaded.
      f. Disc: Bronze.

B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
   1. Description:
      a. Standard: MSS SP-80, Type 4.
      b. CWP Rating: 200 psig (1380 kPa).
      c. Body Design: Horizontal flow.
      e. Ends: Threaded.
      f. Disc: PTFE.

C. Class 150, Bronze Swing Check Valves with Bronze Disc:
   1. Description:
      a. Standard: MSS SP-80, Type 3.
      b. CWP Rating: 300 psig (2070 kPa).
      c. Body Design: Horizontal flow.
      e. Ends: Threaded.
      f. Disc: Bronze.

D. Class 150, Bronze Swing Check Valves with Nonmetallic Disc:
   1. Description:
      a. Standard: MSS SP-80, Type 4.
      b. CWP Rating: 300 psig (2070 kPa).
      c. Body Design: Horizontal flow.
      e. Ends: Threaded.
      f. Disc: PTFE.
PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install swing check valves for proper direction of flow in horizontal position with hinge pin level.

3.2 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Pump-Discharge Check Valves:
   a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
   b. NPS 2-1/2 (DN 65) and Larger: Iron swing check valves with lever and weight or with spring; metal or resilient-seat check valves.

B. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules.
2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules.
6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
3.4 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Bronze Swing Check Valves: Class 150, nonmetallic disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:
   1. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.

END OF SECTION 23 05 23.14
SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Thermal-hanger shield inserts.
   4. Fastener systems.
   5. Equipment supports.

1.2 PERFORMANCE REQUIREMENTS
A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.
B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
   1. Trapeze pipe hangers.
   2. Equipment supports.
C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS
A. Welding certificates.
1.5 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

B. Stainless-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

C. Copper Pipe Hangers:
   1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) minimum compressive strength.

B. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

D. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.
2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless-steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.6 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.


G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

L. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
      b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
      c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
      d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
      e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are required.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.
3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 lb (340 kg).
   b. Medium (MSS Type 32): 1500 lb (680 kg).
   c. Heavy (MSS Type 33): 3000 lb (1360 kg).
8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 23 05 29
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Restrained-spring isolators.
2. Housed-restrained-spring isolators.
3. Resilient pipe guides.
4. Spring hangers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Delegated-Design Submittal: For each vibration isolation device.

1. Include design calculations for selecting vibration isolators.

PART 2 - PRODUCTS

2.1 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint

1. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

   a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
   b. Top plate with threaded mounting holes.
   c. Internal leveling bolt that acts as blocking during installation.

2. Restraint: Limit stop as required for equipment and authorities having jurisdiction.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

4. Minimum Additional Travel: 50 percent of the required deflection at rated load.

5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
2.2 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing.

1. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
   
a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
   b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.3 RESILIENT PIPE GUIDES

A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch- (13-mm-) thick neoprene.

1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.4 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 - EXECUTION

3.1 VIBRATION CONTROL DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork.

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

END OF SECTION 23 05 48.13
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Duct labels.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Material and Thickness: aluminum, 0.032-inch (0.8-mm) or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
   3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
   4. Fasteners: Stainless-steel rivets
   5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
   2. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
   3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
   4. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm),
and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

5. Fasteners: Stainless-steel rivets

6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.

B. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

D. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

E. Fasteners: Stainless-steel rivets

F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

G. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.

B. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

D. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

E. Fasteners: Stainless-steel rivets

F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

G. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.
3.3 PIPE LABEL INSTALLATION

A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.

3.4 DUCT LABEL INSTALLATION

A. Install plastic-laminated duct labels with permanent adhesive on air ducts.

B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet (15 m) in each space where ducts are exposed or concealed by removable ceiling system.

END OF SECTION 23 05 53
SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing Air Systems:
   a. Constant-volume air systems.
   b. Variable-air-volume systems.

2. Balancing Hydronic Piping Systems:
   a. Constant-flow hydronic systems.
   b. Variable-flow hydronic systems.

1.2 DEFINITIONS

C. TAB: Testing, adjusting, and balancing.
D. TABB: Testing, Adjusting, and Balancing Bureau.
E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
F. TDH: Total dynamic head.

1.3 ACTION SUBMITTALS

A. LEED Submittals:
   1. Air-Balance Report for Prerequisite IEQ 1: Documentation indicating that work complies with ASHRAE 62.1, Section 7.2.2 – “Air Balancing.”
   2. TAB Report for Prerequisite EA 2: Documentation indicating that work complies with ASHRAE/IESNA 90.1, Section 6.7.2.3 – “System Balancing.”

1.4 INFORMATIONAL SUBMITTALS

B. Certified TAB reports.

1.5 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by NEBB.
   1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB.
   2. TAB Technician: Employee of the TAB specialist and certified by NEBB as a TAB technician.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures for balancing the systems.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:
   a. Duct systems are complete with terminals installed.
   b. Volume, smoke, and fire dampers are open and functional.
   c. Clean filters are installed.
   d. Fans are operating, free of vibration, and rotating in correct direction.
   e. Variable-frequency controllers' startup is complete and safeties are verified.
   f. Automatic temperature-control systems are operational.
g. Ceilings are installed.

h. Windows and doors are installed.

i. Suitable access to balancing devices and equipment is provided.

2. Hydronics:

a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.

b. Piping is complete with terminals installed.

c. Water treatment is complete.

d. Systems are flushed, filled, and air purged.

e. Strainers are pulled and cleaned.

f. Control valves are functioning per the sequence of operation.

g. Shutoff and balance valves have been verified to be 100 percent open.

h. Pumps are started and proper rotation is verified.

i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.

j. Variable-frequency controllers' startup is complete and safeties are verified.

k. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."

3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.
3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

   a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
   b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
   c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
   d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

2. Measure fan static pressures as follows:

   a. Measure static pressure directly at the fan outlet or through the flexible connection.
   b. Measure static pressure directly at the fan inlet or through the flexible connection.
c. Measure static pressure across each component that makes up the air-handling system.
d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

4. Obtain approval from commissioning authority for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
   a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
   b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
   c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
   d. Adjust controls so that terminal is calling for minimum airflow.
   e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
   f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.
   g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.

4. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
   a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
   b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
   c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
   d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
   e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

5. Measure fan static pressures as follows:
   a. Measure static pressure directly at the fan outlet or through the flexible connection.
   b. Measure static pressure directly at the fan inlet or through the flexible connection.
   c. Measure static pressure across each component that makes up the air-handling system.
   d. Report any artificial loading of filters at the time static pressures are measured.

6. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
b. Verify that terminal units are meeting design airflow under system maximum flow.

7. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.

8. Verify final system conditions as follows:
   a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
   b. Re-measure and confirm that total airflow is within design.
   c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
   d. Mark final settings.
   e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
   f. Verify tracking between supply and return fans.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS
A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
   1. Check liquid level in expansion tank.
   2. Check highest vent for adequate pressure.
   3. Check flow-control valves for proper position.
   4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
   5. Verify that motor starters are equipped with properly sized thermal protection.
   6. Check that air has been purged from the system.

3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS
A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:
   1. Verify that the differential-pressure sensor is located as indicated.
   2. Determine whether there is diversity in the system.

C. For systems with no diversity:
1. Adjust pumps to deliver total design gpm.
   a. Measure total water flow.
      1) Position valves for full flow through coils.
      2) Measure flow by main flow meter, if installed.
      3) If main flow meter is not installed, determine flow by pump TDH or
echanger pressure drop.
   b. Measure pump TDH as follows:
      1) Measure discharge pressure directly at the pump outlet flange or in
discharge pipe prior to any valves.
      2) Measure inlet pressure directly at the pump inlet flange or in suction pipe
prior to any valves or strainers.
      3) Convert pressure to head and correct for differences in gage heights.
      4) Verify pump impeller size by measuring the TDH with the discharge valve
closed. Note the point on manufacturer's pump curve at zero flow and verify
that the pump has the intended impeller size.
      5) With valves open, read pump TDH. Adjust pump discharge valve until
design water flow is achieved.
   c. Monitor motor performance during procedures and do not operate motor in an
overloaded condition.

2. Adjust flow-measuring devices installed in mains and branches to design water flows.
   a. Measure flow in main and branch pipes.
   b. Adjust main and branch balance valves for design flow.
   c. Re-measure each main and branch after all have been adjusted.

3. Adjust flow-measuring devices installed at terminals for each space to design water
flows.
   a. Measure flow at terminals.
   b. Adjust each terminal to design flow.
   c. Re-measure each terminal after it is adjusted.
   d. Position control valves to bypass the coil and adjust the bypass valve to maintain
design flow.
   e. Perform temperature tests after flows have been balanced.

4. For systems with pressure-independent valves at terminals:
   a. Measure differential pressure and verify that it is within manufacturer's specified
range.
   b. Perform temperature tests after flows have been verified.

5. For systems without pressure-independent valves or flow-measuring devices at terminals:
   a. Measure and balance coils by either coil pressure drop or temperature method.
b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

6. Prior to verifying final system conditions, determine the system differential-pressure set point.

7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.

8. Mark final settings and verify that all memory stops have been set.

9. Verify final system conditions as follows:
   a. Re-measure and confirm that total water flow is within design.
   b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
   c. Mark final settings.

10. Verify that memory stops have been set.

D. For systems with diversity:

1. Determine diversity factor.

2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.

3. Adjust pumps to deliver total design gpm.

   a. Measure total water flow.

      1) Position valves for full flow through coils.
      2) Measure flow by main flow meter, if installed.
      3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

   b. Measure pump TDH as follows:

      1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
      2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
      3) Convert pressure to head and correct for differences in gage heights.
      4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
      5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.


4. Adjust flow-measuring devices installed in mains and branches to design water flows.
a. Measure flow in main and branch pipes.
b. Adjust main and branch balance valves for design flow.
c. Re-measure each main and branch after all have been adjusted.

5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
   a. Measure flow at terminals.
   b. Adjust each terminal to design flow.
   c. Re-measure each terminal after it is adjusted.
   d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
   e. Perform temperature tests after flows have been balanced.

6. For systems with pressure-independent valves at terminals:
   a. Measure differential pressure, and verify that it is within manufacturer's specified range.
   b. Perform temperature tests after flows have been verified.

7. For systems without pressure-independent valves or flow-measuring devices at terminals:
   a. Measure and balance coils by either coil pressure drop or temperature method.
   b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.

9. Prior to verifying final system conditions, determine system differential-pressure set point.

10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.

11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:
   a. Re-measure and confirm that total water flow is within design.
   b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
   c. Mark final settings.

13. Verify that memory stops have been set.

3.9 TOLERANCES
A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
   2. Air Outlets and Inlets: Plus or minus 10 percent.
   3. Heating-Water Flow Rate: Plus or minus 10 percent.
   4. Cooling-Water Flow Rate: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.10 FINAL REPORT
A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.
   3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers' test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:
   1. Title page.
   2. Name and address of the TAB specialist.
   3. Project name.
   4. Project location.
   5. Architect's name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
   a. Indicated versus final performance.
   b. Notable characteristics of systems.
   c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
   a. Settings for outdoor-, return-, and exhaust-air dampers.
   b. Conditions of filters.
   c. Cooling coil, wet- and dry-bulb conditions.
   d. Face and bypass damper settings at coils.
   e. Fan drive settings including settings and percentage of maximum pitch diameter.
   f. Inlet vane settings for variable-air-volume systems.
   g. Settings for supply-air, static-pressure controller.
   h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer's serial number.
   f. Unit arrangement and class.
   g. Discharge arrangement.
   h. Sheave make, size in inches (mm), and bore.
   i. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
   j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:
   a. Motor make, and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches (mm), and bore.
   f. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm (L/s).
   b. Total system static pressure in inches wg (Pa).
   c. Fan rpm.
   d. Discharge static pressure in inches wg (Pa).
   e. Filter static-pressure differential in inches wg (Pa).
   f. Preheat-coil static-pressure differential in inches wg (Pa).
   g. Cooling-coil static-pressure differential in inches wg (Pa).
   h. Heating-coil static-pressure differential in inches wg (Pa).
   i. Outdoor airflow in cfm (L/s).
   j. Return airflow in cfm (L/s).
   k. Outdoor-air damper position.
   l. Return-air damper position.
   m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:
   a. System identification.
   b. Location.
   c. Coil type.
   d. Number of rows.
   e. Fin spacing in fins per inch (mm) o.c.
   f. Make and model number.
   g. Face area in sq. ft. (sq. m).
   h. Tube size in NPS (DN).
   i. Tube and fin materials.
   j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm (L/s).
   b. Average face velocity in fpm (m/s).
   c. Air pressure drop in inches wg (Pa).
   d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
   e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
   f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
h. Water flow rate in gpm (L/s).
i. Water pressure differential in feet of head or psig (kPa).
j. Entering-water temperature in deg F (deg C).
k. Leaving-water temperature in deg F (deg C).
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig (kPa).
n. Refrigerant suction temperature in deg F (deg C).
o. Inlet steam pressure in psig (kPa).

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:
   a. System identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer's serial number.
   f. Fuel type in input data.
   g. Output capacity in Btu/h (kW).
   h. Ignition type.
   i. Burner-control types.
   j. Motor horsepower and rpm.
   k. Motor volts, phase, and hertz.
   l. Motor full-load amperage and service factor.
   m. Sheave make, size in inches (mm), and bore.
   n. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).

2. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm (L/s).
   b. Entering-air temperature in deg F (deg C).
   c. Leaving-air temperature in deg F (deg C).
   d. Air temperature differential in deg F (deg C).
   e. Entering-air static pressure in inches wg (Pa).
   f. Leaving-air static pressure in inches wg (Pa).
   g. Air static-pressure differential in inches wg (Pa).
   h. Low-fire fuel input in Btu/h (kW).
   i. High-fire fuel input in Btu/h (kW).
   j. Manifold pressure in psig (kPa).
   k. High-temperature-limit setting in deg F (deg C).
   l. Operating set point in Btu/h (kW).
   m. Motor voltage at each connection.
   n. Motor amperage for each phase.
   o. Heating value of fuel in Btu/h (kW).
H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:
   a. System identification.
   b. Location.
   c. Coil identification.
   d. Capacity in Btu/h (kW).
   e. Number of stages.
   f. Connected volts, phase, and hertz.
   g. Rated amperage.
   h. Airflow rate in cfm (L/s).
   i. Face area in sq. ft. (sq. m).
   j. Minimum face velocity in fpm (m/s).

2. Test Data (Indicated and Actual Values):
   a. Heat output in Btu/h (kW).
   b. Airflow rate in cfm (L/s).
   c. Air velocity in fpm (m/s).
   d. Entering-air temperature in deg F (deg C).
   e. Leaving-air temperature in deg F (deg C).
   f. Voltage at each connection.
   g. Amperage for each phase.

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:
   a. System identification.
   b. Location.
   c. Make and type.
   d. Model number and size.
   e. Manufacturer's serial number.
   f. Arrangement and class.
   g. Sheave make, size in inches (mm), and bore.
   h. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).

2. Motor Data:
   a. Motor make, and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches (mm), and bore.
   f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
   g. Number, make, and size of belts.
3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm (L/s).
   b. Total system static pressure in inches wg (Pa).
   c. Fan rpm.
   d. Discharge static pressure in inches wg (Pa).
   e. Suction static pressure in inches wg (Pa).

J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
   a. System and air-handling-unit number.
   b. Location and zone.
   c. Traverse air temperature in deg F (deg C).
   d. Duct static pressure in inches wg (Pa).
   e. Duct size in inches (mm).
   f. Duct area in sq. ft. (sq. m).
   g. Indicated airflow rate in cfm (L/s).
   h. Indicated velocity in fpm (m/s).
   i. Actual airflow rate in cfm (L/s).
   j. Actual average velocity in fpm (m/s).
   k. Barometric pressure in psig (Pa).

K. Air-Terminal-Device Reports:

1. Unit Data:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. Apparatus used for test.
   d. Area served.
   e. Make.
   f. Number from system diagram.
   g. Type and model number.
   h. Size.
   i. Effective area in sq. ft. (sq. m).

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm (L/s).
   b. Air velocity in fpm (m/s).
   c. Preliminary airflow rate as needed in cfm (L/s).
   d. Preliminary velocity as needed in fpm (m/s).
   e. Final airflow rate in cfm (L/s).
   f. Final velocity in fpm (m/s).
   g. Space temperature in deg F (deg C).
L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:
   a. System and air-handling-unit identification.
   b. Location and zone.
   c. Room or riser served.
   d. Coil make and size.
   e. Flowmeter type.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm (L/s).
   b. Entering-water temperature in deg F (deg C).
   c. Leaving-water temperature in deg F (deg C).
   d. Water pressure drop in feet of head or psig (kPa).
   e. Entering-air temperature in deg F (deg C).
   f. Leaving-air temperature in deg F (deg C).

M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Service.
   d. Make and size.
   e. Model number and serial number.
   f. Water flow rate in gpm (L/s).
   g. Water pressure differential in feet of head or psig (kPa).
   h. Required net positive suction head in feet of head or psig (kPa).
   i. Pump rpm.
   j. Impeller diameter in inches (mm).
   k. Motor make and frame size.
   l. Motor horsepower and rpm.
   m. Voltage at each connection.
   n. Amperage for each phase.
   o. Full-load amperage and service factor.
   p. Seal type.

2. Test Data (Indicated and Actual Values):
   a. Static head in feet of head or psig (kPa).
   b. Pump shutoff pressure in feet of head or psig (kPa).
   c. Actual impeller size in inches (mm).
   d. Full-open flow rate in gpm (L/s).
   e. Full-open pressure in feet of head or psig (kPa).
   f. Final discharge pressure in feet of head or psig (kPa).
   g. Final suction pressure in feet of head or psig (kPa).
h. Final total pressure in feet of head or psig (kPa).
i. Final water flow rate in gpm (L/s).
j. Voltage at each connection.
k. Amperage for each phase.

N. Instrument Calibration Reports:

1. Report Data:
   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.

3.11 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of commissioning authority.

B. Commissioning authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.

3. If the second verification also fails, design professional may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.
3.12 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 05 93
PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following duct services:
   1. Indoor, concealed supply and outdoor air.
   2. Indoor, exposed supply and outdoor air.
   3. Indoor, concealed return located in unconditioned space.
   4. Indoor, exposed return located in unconditioned space.
   5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
   6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
   7. Outdoor, concealed supply and return.
   8. Outdoor, exposed supply and return.

B. Related Sections:
   1. Section 230716 "HVAC Equipment Insulation."
   2. Section 230719 "HVAC Piping Insulation."
   3. Section 233113 "Metal Ducts" for duct liners.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
   2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services’ “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.”

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
   3. Detail application of field-applied jackets.
   4. Detail application at linkages of control devices.
1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS


B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type II with factory-applied vinyl jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

   1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
   1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
   3. Solids Content: 60 percent by volume and 66 percent by weight.

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
   5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
   5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perm) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH
A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for ducts.

2.8 FIELD-APPLIED JACKETS
A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Adhesive: As recommended by jacket material manufacturer.
   1. Factory cut and rolled to size.
   2. Finish and thickness are indicated in field-applied jacket schedules.
   3. Moisture Barrier for Indoor Applications: 2.5-mil- (0.063-mm-) thick polysurlyn.
   4. Moisture Barrier for Outdoor Applications: 2.5-mil- (0.063-mm-) thick polysurlyn.
E. Self-Adhesive Outdoor Jacket: 60-mil- (1.5-mm-) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.

2.9 TAPES
A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Width: 3 inches (75 mm).
   2. Thickness: 11.5 mils (0.29 mm).
   3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Width: 3 inches (75 mm).
   2. Thickness: 6.5 mils (0.16 mm).
   3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
   1. Width: 2 inches (50 mm).
   2. Thickness: 6 mils (0.15 mm).
   3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
   4. Elongation: 500 percent.
   5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   1. Width: 2 inches (50 mm).
   2. Thickness: 3.7 mils (0.093 mm).
   3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
   4. Elongation: 5 percent.
   5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.10 SECUREMENTS

A. Aluminum Bands: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 3/4 inch (19 mm) wide with closed seal.

B. Insulation Pins and Hangers:
   1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
      a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
      b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
   b. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
   c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
   b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
   c. Adhesive-backed base with a peel-off protective cover.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

   a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

   C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.
   D. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.

2.11 CORNER ANGLES

   A. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
B. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches (100 mm) o.c.
   a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches (50 mm).
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
   b. On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
   e. Impale insulation over pins and attach speed washers.
   f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).

5. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
   b. On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
   e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.
3.6 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

3.7 FINISHES

A. Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.


B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless-steel jackets.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

   1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each duct system defined in the "Duct Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

   1. Indoor, concealed supply and outdoor air.
   2. Indoor, exposed supply and outdoor air.
   3. Indoor, concealed return located in unconditioned space.
   4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
7. Outdoor, concealed supply and return.
8. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
5. Flexible connectors.
7. Factory-insulated access panels and doors.

3.10 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. See schedule on drawings.

3.11 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. See schedule on drawings.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:

1. None.
2. PVC, Color-Coded by System: 30 mils (0.8 mm) thick.
3. Aluminum, Corrugated: 0.024 inch (0.61 mm) thick.

D. Ducts and Plenums, Exposed:

1. None.
2. PVC, Color-Coded by System: 30 mils (0.8 mm) thick.
3. Aluminum, Corrugated: 0.024 inch (0.61 mm) thick.

3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:
   1. None.
   2. PVC, Color-Coded by System: 30 mils (0.8 mm) thick.
   3. Aluminum, Corrugated: 0.024 inch (0.61 mm) thick.

D. Ducts and Plenums, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):
   1. Aluminum, Corrugated: 0.024 inch (0.61 mm) thick.

E. Ducts and Plenums, Exposed, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):
   1. Aluminum, Smooth with 1-1/4-Inch- (32-mm-) Deep Corrugations: 0.040 inch (1.0 mm) thick.

END OF SECTION 23 07 13
PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following HVAC equipment that is not factory insulated:
   1. Heating, hot-water pumps.
   2. Expansion/compression tanks.
   3. Air separators.

B. Related Sections:
   1. Section 230713 "Duct Insulation."
   2. Section 230719 "HVAC Piping Insulation."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
   2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services’ “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.”

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail attachment and covering of heat tracing inside insulation.
   3. Detail removable insulation at equipment connections.
   4. Detail application of field-applied jackets.
   5. Detail application at linkages of control devices.
   6. Detail field application for each equipment type.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction.
Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Block Insulation: ASTM C 552, Type I.
2. Special-Shaped Insulation: ASTM C 552, Type III.
3. Board Insulation: ASTM C 552, Type IV.
4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type II with factory-applied vinyl jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

J. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F (0.038 W/m x K) after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.
2.2 INSULATING CEMENTS


2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F (minus 73 to plus 93 deg C).
   1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F (29 to plus 60 deg C).

F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

G. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: 60 percent by volume and 66 percent by weight.

2.5 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Permanently flexible, elastomeric sealant.
5. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
6. Color: White or gray.
7. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 FACTORY-APPLIED JACkETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm (0.013 metric perm) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
6. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm (0.007 metric perm) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perm) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for equipment.
2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Adhesive: As recommended by jacket material manufacturer.
   2. Color: Color as selected by Architect.
   3. Factory-fabricated tank heads and tank side panels.

   1. Factory cut and rolled to size.
   2. Finish and thickness are indicated in field-applied jacket schedules.
   3. Moisture Barrier for Indoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
   4. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
   5. Factory-Fabricated Fitting Covers:
      a. Same material, finish, and thickness as jacket.
      b. Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      c. Tee covers.
      d. Flange and union covers.
      e. End caps.
      f. Beveled collars.
      g. Valve covers.
      h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Self-Adhesive Outdoor Jacket: 60-mil- (1.5-mm-) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.

F. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm (0.013 metric perm) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

G. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm (0.007 metric perm) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Width: 3 inches (75 mm).
   2. Thickness: 11.5 mils (0.29 mm).
   3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Width: 3 inches (75 mm).
   2. Thickness: 6.5 mils (0.16 mm).
   3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
   1. Width: 2 inches (50 mm).
   2. Thickness: 6 mils (0.15 mm).
   3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
   4. Elongation: 500 percent.
   5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   1. Width: 2 inches (50 mm).
   2. Thickness: 3.7 mils (0.093 mm).
   3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
   4. Elongation: 5 percent.
   5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
   1. Width: 3 inches (75 mm).
   2. Film Thickness: 4 mils (0.10 mm).
   3. Adhesive Thickness: 1.5 mils (0.04 mm).
   4. Elongation at Break: 145 percent.
   5. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
   1. Width: 3 inches (75 mm).
   2. Film Thickness: 6 mils (0.15 mm).
   3. Adhesive Thickness: 1.5 mils (0.04 mm).
   4. Elongation at Break: 145 percent.
   5. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.
2.10 SECUREMENTS

A. Aluminum Bands: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 3/4 inch (19 mm) wide with closed seal.

B. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
   a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
   b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
   c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
   a. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
   b. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
   c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
   a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
   b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
   c. Adhesive-backed base with a peel-off protective cover.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
   a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.
D. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.

2.11 CORNER ANGLES

A. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches (100 mm) o.c.

a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
5. Handholes.
6. Cleanouts.

3.3 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
   a. Do not weld anchor pins to ASME-labeled pressure vessels.
   b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
   c. On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16 inches (400 mm) o.c. in both directions.
   d. Do not overcompress insulation during installation.
   e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
   f. Impale insulation over anchor pins and attach speed washers.
   g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.

6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (150 mm) from each end. Install wire or cable between two circumferential girdles 12 inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.

7. Stagger joints between insulation layers at least 3 inches (75 mm).

8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.

9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.

10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.

2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch (150-mm) centers, starting at corners. Install 3/8-inch- (10-mm-) diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.

2. Fabricate boxes from stainless steel, at least 0.050 inch (1.3 mm) thick.

3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.4 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

D. Where PVDC jackets are indicated, install as follows:

1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches (850 mm) or less. 33-1/2-inch- (850-mm-) circumference limit allows for 2-inch- (50-mm-) overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
2. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.5 FINISHES

A. Equipment Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.
B. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.7 BREECHING INSULATION SCHEDULE

A. Round, Exposed Breeching and Connector: High-temperature mineral-fiber blanket, 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

B. Round, Concealed Breeching and Connector Insulation: High-temperature mineral-fiber blanket, 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

3.8 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Heating-Hot-Water Pump Insulation: Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

D. Heating-Hot-Water Expansion/Compression Tank Insulation: Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.

E. Heating-Hot-Water Air-Separator Insulation: Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.

3.9 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:

1. None.
2. PVC, Color-Coded by System: 30 mils (0.8 mm) thick.
3. Aluminum, Corrugated: 0.024 inch (0.61 mm) thick.

D. Equipment, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):

1. None.
2. PVC, Color-Coded by System: 30 mils (0.8 mm) thick.
3. Aluminum, Corrugated: 0.024 inch (0.61 mm) thick.
E. Equipment, Exposed, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):

1. None,
2. Aluminum, Smooth with 2-1/2-Inch- (65-mm-) Deep Corrugations: 0.032 inch (0.81 mm) thick.

3.10 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):

1. Aluminum, Smooth with Z-Shaped Locking Seam: 0.024 inch (0.61 mm) thick.
2. <Insert jacket type>.

D. Equipment, Exposed, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):

1. Aluminum, Smooth with 1-1/4-Inch- (32-mm-) Deep Corrugations: 0.040 inch (1.0 mm) thick.

END OF SECTION 23 07 16
PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following HVAC piping systems:
   1. Heating hot-water piping, indoors
   2. Refrigerant suction and hot-gas piping, indoors and outdoors.

B. Related Sections:
   1. Section 230713 "Duct Insulation."
   2. Section 230716 "HVAC Equipment Insulation."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals
   1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
   2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services’ “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.”

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail attachment and covering of heat tracing inside insulation.
   3. Detail insulation application at pipe expansion joints for each type of insulation.
   4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   5. Detail removable insulation at piping specialties.
   6. Detail application of field-applied jackets.
   7. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.
1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Block Insulation: ASTM C 552, Type I.
2. Special-Shaped Insulation: ASTM C 552, Type III.
3. Board Insulation: ASTM C 552, Type IV.
4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
5. Preformed Pipe Insulation with Factory-Applied [ASJ] [ASJ-SSL]: Comply with ASTM C 552, Type II, Class 2.
6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 1290, Type I.

H. Mineral-Fiber, Preformed Pipe Insulation:
1. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2. Type II, 1200 deg F (649 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory-applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.

J. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

2.2 INSULATING CEMENTS


2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F (minus 73 to plus 93 deg C).

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."


1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: 60 percent by volume and 66 percent by weight.
2.5 SEALANTS

A. Joint Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Permanently flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
   5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. FSK and Metal Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
   5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
   5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm (0.013 metric perm) when tested according to ASTM E 96/E 96M and with a flame-developed index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
6. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm (0.007 metric perm) when tested according to ASTM E 96/E 96M and with a flame-developed index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perms) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for pipe.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
B. FSK Jacket: Aluminum-foil face, fiberglass-reinforced scrim with kraft-paper backing.
C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Adhesive: As recommended by jacket material manufacturer.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
1. Factory cut and rolled to size.
2. Finish and thickness are indicated in field-applied jacket schedules.
3. Moisture Barrier for Indoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
4. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
5. Factory-Fabricated Fitting Covers:
   a. Same material, finish, and thickness as jacket.
   b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
   c. Tee covers.
   d. Flange and union covers.
   e. End caps.
   f. Beveled collars.
   g. Valve covers.
   h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Self-Adhesive Outdoor Jacket: 60-mil- (1.5-mm-) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.
   1. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms (0.013 metric perms) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

F. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms (0.007 metric perms) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.


2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Width: 3 inches (75 mm).
   2. Thickness: 11.5 mils (0.29 mm).
   3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Width: 3 inches (75 mm).
   2. Thickness: 6.5 mils (0.16 mm).
   3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches (50 mm).
2. Thickness: 6 mils (0.15 mm).
3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches (50 mm).
2. Thickness: 3.7 mils (0.093 mm).
3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Width: 3 inches (75 mm).
2. Film Thickness: 4 mils (0.10 mm).
3. Adhesive Thickness: 1.5 mils (0.04 mm).
4. Elongation at Break: 145 percent.
5. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Width: 3 inches (75 mm).
2. Film Thickness: 6 mils (0.15 mm).
3. Adhesive Thickness: 1.5 mils (0.04 mm).
4. Elongation at Break: 145 percent.
5. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

2.10 SECUREMENTS

A. Aluminum Bands: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 3/4 inch (19 mm) wide with closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

C. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.
PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches (100 mm) o.c.
   a. For below-ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
5. Handholes.
6. Cleanouts.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.

4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).

4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.

2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly
against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches (150 mm) o.c.

4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of polyolefin pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

D. Where PVDC jackets are indicated, install as follows:
   1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
   2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches (50 mm) over the previous section. Adhere lap seal using
adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.

3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.

4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches (850 mm) or less. The 33-1/2-inch- (850-mm-) circumference limit allows for 2-inch- (50-mm-) overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.

5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.10 FINISHES

A. Pipe Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.


B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

   1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.12 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Heating-Hot-Water Supply and Return, 200 Deg F (93 Deg C) and Below: Insulation shall be one of the following:
   1. Cellular Glass: 2 inches (50 mm) thick.
   2. Mineral-Fiber, Preformed Pipe, Type I: 2 inches (50 mm) thick.

B. Refrigerant Suction and Hot-Gas Piping: Flexible elastomeric, 1 inch (25 mm) thick.

C. Refrigerant Suction and Hot-Gas Flexible Tubing: Flexible elastomeric, 1 inch (25 mm) thick.

3.14 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Heating-Hot-Water Supply and Return, 200 Deg F (93 Deg C) and Below: Insulation shall be one of the following:
   1. Cellular Glass: 3 inches (75 mm) thick.
   2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.

B. Refrigerant Suction and Hot-Gas Piping: Insulation shall be one of the following:
   1. Cellular Glass: 2 inches (50 mm) thick.
   2. Flexible Elastomeric: 2 inches (50 mm) thick.
   3. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
   4. Polyolefin: 2 inches (50 mm) thick.

C. Refrigerant Suction and Hot-Gas Flexible Tubing: Insulation shall be one of the following:
   1. Flexible Elastomeric: 2 inches (50 mm) thick.
   2. Polyolefin: 2 inches (50 mm) thick.
3.15 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Loose-fill insulation, for belowground piping, is specified in Section 232113.13 "Underground Hydronic Piping" and Section 336313 "Underground Steam and Condensate Distribution Piping."

B. Heating-Hot-Water Supply and Return, All Sizes, 200 Deg F (93 Deg C) and Below: Cellular glass, 3 inches (75 mm) thick.

3.16 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:
   1. None.
   2. PVC, Color-Coded by System: 30 mils (0.8 mm) thick.
   3. Aluminum, Corrugated: 0.024 inch (0.61 mm) thick.

D. Piping, Exposed:
   1. None.
   2. PVC, Color-Coded by System: 30 mils (0.8 mm) thick.
   3. Aluminum, Corrugated: 0.024 inch (0.61 mm) thick.

3.17 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:
   1. None.
   2. PVC, Color-Coded by System: 30 mils (0.8 mm) thick.
   3. Aluminum, Corrugated: 0.024 inch (0.61 mm) thick.

D. Piping, Exposed:
   1. PVC: 30 mils (0.8 mm) thick.
3.18 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 23 07 19
SECTION 23 08 00 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes commissioning process requirements for the following HVAC&R systems, assemblies, and equipment:

1. Energy supply systems, including gas supply.
2. Heat generation systems, including hot-water boilers and auxiliary equipment.
3. Cooling generation systems, including direct-expansion systems.
4. Distribution systems, including air distribution (heating and cooling) systems, exhaust systems, and air-handling units.
5. Terminal and packaged units, including unit heaters, electric heating, and packaged units.
6. Vibration and sound systems, including sound attenuation.
7. Controls and instrumentation, including BAS.
8. Systems testing and balancing verification, including heating-water piping systems, domestic hot-water circulating systems, supply-air systems, return-air systems, and exhaust-air systems.

B. Related Requirements:

1. Section 019113 "General Commissioning Requirements" for general commissioning process requirements and Commissioning Coordinator responsibilities.

1.2 DEFINITIONS

A. BAS: Building automation system.
B. DDC: Direct digital controls.
D. "Systems," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
E. TAB: Testing, adjusting, and balancing.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For BAS and HVAC&R Testing Technician.
B. Construction Checklists: For the following:

1. Vibration and seismic controls for HVAC&R piping and equipment.
2. Instrumentation and control for HVAC&R.
3. Heating-water piping and accessories.
4. Refrigerant piping.
5. Metal ducts and accessories.
6. Fans.
7. Particulate air filtration.
8. Air-handling units.

1.4 QUALITY ASSURANCE

A. BAS Testing Technician Qualifications: Technicians to perform BAS construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:

1. Journey-level or equivalent skill level with knowledge of BAS, HVAC&R, electrical concepts, and building operations.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.

B. HVAC&R Testing Technician Qualifications: Technicians to perform HVAC&R construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:

1. Journey-level or equivalent skill level. Vocational School four-year program graduate or an Associates degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC&R systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC&R equipment, assemblies, and systems.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. One of the following:
   b. Associated Air Balance Council (AABC) Certified Test and Balance Technician.
   c. Owner retains the right to waive NEBB or AABC Certification.

C. Testing Equipment and Instrumentation Quality and Calibration: For test equipment and instrumentation required to perform HVAC&R commissioning work, perform the following:
1. Submit test equipment and instrumentation list. For each equipment or instrument, identify the following:
   a. Equipment/instrument identification number.
   b. Planned commissioning application or use.
   c. Manufacturer, make, model, and serial number.
   d. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.

2. Test equipment and instrumentation shall meet the following criteria:
   a. Capable of testing and measuring performance within the specified acceptance criteria.
   b. Be calibrated at the manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
   c. Be maintained in good repair and operating condition throughout the duration of use on this Project.
   d. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

D. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the commissioning process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, perform the following:
   a. Submit proprietary instrumentation and tools list. For each instrument or tool, identify the following:
      1) Instrument or tool identification number.
      2) Equipment schedule designation of equipment for which the instrument or tool is required.
      3) Manufacturer, make, model, and serial number.
      4) Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.
   b. Include a separate list of proprietary test instrumentation and tools in the operation and maintenance manuals.
   c. HVAC&R proprietary test instrumentation and tools become the property of Owner at the time of Substantial Completion.
PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL TESTING REQUIREMENTS

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents and approved Shop Drawings and submittals.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved Shop Drawings and submittals, and that pretest set points have been recorded.

C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Construction Checklists: Prepare and submit detailed construction checklists for HVAC&R systems, subsystems, equipment, and components.
   1. Contributors to the development of construction checklists shall include, but are not limited to, the following:
      a. HVAC&R systems and equipment installers.
      b. TAB technicians.
      c. HVAC&R instrumentation and controls installers.

F. Perform tests using design conditions, whenever possible.
   1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by Commissioning Coordinator and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
   2. Commissioning test procedures may direct that set points be altered when simulating conditions is impractical.
   3. Commissioning test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

G. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to Owner. After deficiencies are resolved, reschedule tests.
H. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.

I. Coordinate schedule with, and perform the following activities at the direction of, Commissioning Coordinator.

J. Comply with construction checklist requirements, including material verification, installation checks, start-up, and performance tests requirements specified in Sections specifying HVAC systems and equipment.

K. Provide technicians, instrumentation, tools, and equipment to complete and document the following:
   1. Performance tests.
   2. Demonstration of a sample of performance tests.
   3. Commissioning tests.

3.2 TAB COMMISSIONING TESTS

A. TAB Verification:
   1. Conditions of the Test:
      a. Commissioning Test Demonstration Sampling Rate: As specified in "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
      b. Systems operating in full heating mode with minimum outside-air volume.
      c. Systems operating in full cooling mode with minimum outside-air volume.
      d. For measurements at air-handling units with economizer controls; systems operating in economizer mode with 100 percent outside air.
   2. Acceptance Criteria:
      a. Under all conditions, rechecked measurements comply with "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
      b. Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than two times the tolerances allowed.
      c. Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.

3.3 HEATING CONTROL SYSTEM COMMISSIONING TESTS

A. Heating-Water Supply Temperature Control:
   1. Prerequisites: Installation verification of the following:
      a. Startup of boiler.
b. Startup of heating-water pump(s).
c. TAB of heating-water flow and pressure.
d. Input Device: Heating-water supply temperature; thermostat.
e. Output Device: Control valve
f. Display the following at the operator's workstation:
   1) Heating-water supply temperature.
   2) Heating-water supply temperature set point.
   3) Control-valve position.

2. Conditions of the Test:
   a. Minimum heating-water flow.
   b. Midrange Heating-Water Flow: 50 to 60 percent of maximum.
   c. Maximum heating-water flow.

3. Acceptance Criteria: Under all conditions, heating-water supply temperature is within plus or minus 2.0 deg F (1.1 deg C) of set point.

B. Heating-Water Supply Temperature Reset:

1. Prerequisites: Installation verification of the following:
   a. Startup of boiler.
   b. Startup of heating-water pump(s).
   c. TAB of heating-water flow and pressure.
   d. Input Device: Heating-water supply temperature; thermostat.
   e. Input Device: Outdoor-air temperature; outdoor-air sensor.
   f. Output Device: Control valve
   g. Display the following at the operator's workstation:
      1) Outdoor-air temperature.
      2) Heating-water supply temperature.
      3) Heating-water supply temperature set point.
      4) Control-valve position.

2. Conditions of the Test: Outdoor-air temperature input value may be overridden for this test.
   a. Low Temperature: Outdoor-air temperature between minus 30 and 0 deg F (minus 34 and minus 18 deg C).
   b. Midrange Temperature: Outdoor-air temperature between 30 and 45 deg F (minus 1 and plus 7 deg C).
   c. High Temperature: Outdoor-air temperature above 65 deg F (18 deg C).

3. Acceptance Criteria: Heating-water supply temperature resets in straight-line relationship with outdoor-air temperature for the following reset schedule. Under all conditions, heating-water supply temperature is within 2.0 deg F (1.1 deg C) of set point.
a. 195 deg F (90 deg C) heating water when outdoor-air temperature is minus 30 deg F (minus 34 deg C).
b. 130 deg F (54 deg C) heating water when outdoor-air temperature is 65 deg F (18 deg C).
c. Under all conditions, heating-water supply temperature is within plus or minus 2.0 deg F (1.1 deg C) of set point.

C. Control Primary Circulating Pump(s):

1. Prerequisites: Installation verification of the following:
   a. Startup of heating-water pump(s).
   b. Input Device: Outdoor-air temperature; outdoor-air sensor.
   c. Output Device: Heating-water pump; DDC system command to starter relay.
   d. Display the following at the operator's workstation:
      1) Outdoor-air temperature.
      2) Operating status of primary circulating pump(s).

2. Conditions of the Test:
   b. Low Temperature: Outdoor-air temperature below 65 deg F (18 deg C).

3. Acceptance Criteria:
   a. High Temperature: Pump(s) are off when outside-air temperature is above 65 deg F (18 deg C).
   b. Low Temperature: Pump(s) are on when outside-air temperature is below 65 deg F (18 deg C).

3.4 TERMINAL UNIT EQUIPMENT COMMISSIONING TESTS

A. Variable-Air-Volume Terminal Air Units with Coils:

1. Prerequisites: Installation verification of the following:
   a. Occupancy Input Device: Occupancy sensor.
   b. Occupancy Output Device: DDC system binary output.
   c. Room Temperature Input Device: Room thermostat.
   d. Room Temperature Output Device: Electronic damper actuators and control-valve operators.
   e. Display the following at the operator's workstation:
      1) Room/area served.
      2) Room occupied/unoccupied.
      3) Room temperature indication.
      4) Room temperature set point.
      5) Room temperature set point, occupied.
6) Room temperature set point, unoccupied.
7) Air-damper position as percentage open.
8) Control-valve position as percentage open.

2. Conditions of the Test:
   a. Commissioning Test Demonstration Sampling Rate: 10 percent of each model/size unit.
   b. Temperature Control - Occupied: Start with the room unoccupied. Occupy the room and observe the change to occupied status. Observe temperature control until room temperature is stable at occupied set point plus or minus 1.0 deg F (0.6 deg C).
   c. Temperature Control - Unoccupied: Start with the room occupied. Vacate the room and observe the change to unoccupied status. Observe temperature control until room temperature is stable at unoccupied set point plus or minus 1.0 deg F (0.6 deg C).

3. Acceptance Criteria:
   a. Temperature Control - Occupied:
      1) Control system status changes from "occupied" to "unoccupied" after the specified time.
      2) Room temperature is stable at occupied set point plus or minus 1.0 deg F (0.6 deg C) within 10 minutes of occupancy. Room temperature does not overshoot or undershoot set point by more than 2.0 deg F (1.1 deg C) during transition.
   b. Temperature Control - Unoccupied:
      1) Control system status changes from "unoccupied" to "occupied" after five minutes of continuous occupancy.
      2) Room temperature is stable at unoccupied set point plus or minus 1.0 deg F (0.6 deg C) within 30 minutes of occupancy.

3.5 AIR-HANDLING SYSTEM COMMISSIONING TESTS

A. Supply Fan(s) Variable-Volume Control:
   1. Prerequisites: Installation verification of the following:
      a. Volume Control Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to conditioned-space static pressure.
      b. Volume Control Output Device: DDC system analog output.
      c. Volume Control Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to conditioned-space static pressure.
      d. Volume Control Output Device: Receiver controller to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.
e. High-Pressure Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to static pressure outside the duct.

f. High-Pressure Output Device: Receiver controller to alarm panel.

g. Display the following at the operator's workstation:

1) Supply-fan-discharge static-pressure indication.
2) Supply-fan-discharge static-pressure set point.
3) Supply-fan airflow rate.
4) Supply-fan speed.

2. Conditions of the Test:

a. Minimum supply-air flow.
b. Midrange Supply-Air Flow: 50 to 60 percent of maximum.
c. Maximum supply-air flow.
d. Excess supply-air discharge static pressure.

3. Acceptance Criteria:

a. At all supply-air flow rates, and during changes in supply-air flow, discharge air static pressure is at set point plus or minus 2 percent.
b. Fan stops and an alarm is initiated at the operator's workstation when supply-air discharge static pressure is at the excess static pressure plus or minus 2 percent.

B. Air-Handler Mixed-Air Control:

1. Prerequisites: Installation verification of the following:

a. Minimum Position Input Device: DDC system time schedule.
b. Output Device: Receiver controller to modulating damper actuator(s).
c. Heating Reset Input Device: Room thermostat.
e. Cooling Reset Input Device: Outdoor- and return-air, duct-mounted thermostats.
f. Display the following at the operator's workstation:

1) Mixed-air-temperature indication.
2) Mixed-air-temperature set point.
3) Mixed-air damper position.

2. Conditions of the Test:

a. Occupied Time Control: Start in unoccupied schedule. Advance to occupied schedule time.
b. Minimum Damper Position Control: Command system to mode in which minimum damper position is required.
c. Heating Reset Control: Create a call for heating.
d. Supply-Air Temperature Control: Override supply-air temperature set point to a value 2.0 deg F (1.1 deg C) above current supply-air temperature.
e. Cooling Reset Control: Override outdoor-air enthalpy to a value that exceeds return-air enthalpy.
f. Unoccupied Time Control: Advance to unoccupied schedule time.
g. Control Data Trend Log: Set up a data trend log of the following input device values and output device commands. Record data at hourly intervals. Submit trend data for 24-hour periods in which natural conditions require heating reset control, supply-air temperature control, and cooling reset control.

1) Minimum position input device.
2) Heating reset input device.
3) Supply-air temperature input device.
4) Cooling reset input device.

3. Acceptance Criteria:
   a. Occupied Time Control: Mixed-air control is active in occupied mode.
   b. Minimum Damper Position Control: Controller opens minimum outdoor-air dampers.
   c. Heating Reset Control: Controller closes minimum outdoor-air dampers.
   d. Supply-Air Temperature Control: Controller modulates outdoor-, return-, and relief-air dampers to maintain temporary supply-air temperature set point plus or minus 1.0 deg F (0.6 deg C).
   e. Cooling Reset Control: Controller sets outdoor-air dampers to minimum position when outdoor-air enthalpy exceeds return-air enthalpy.
   f. Unoccupied Time Control: Controller positions outdoor- and relief-air dampers closed and return-air dampers open.
   g. Control Data Trend Log: Data verifies control according to sequence of control.

END OF SECTION 23 08 00
PART 1 - GENERAL

1.1 A complete system of automatic controls shall be provided as required to accomplish the sequence of control for the various items of equipment and systems being installed. The system shall be a Direct Digital Control System (DDCS) utilizing electric actuation. The DDCS shall be part of an open campus-wide system with a supervisory control and data acquisition system (SCADAS) (by others located at the Ops Center). The DDCS shall consist of micro-processor based digital controllers, control components, communication networks, and control wiring for complete and operable systems. The construction methods and functionality of equipment, controllers, and components required is strictly the responsibility of the provider. The DDCS shall communicate with the SCADAS over the campus wide area network (WAN). A single data drop for the DDCS shall be provided by others. All DDCS communication components and wiring downstream of that single point of data connection shall be provided with the DDCS.

1.2 DDCS OVERVIEW

A. The intent of this specification and related sections is to provide a fully integrated, open, interoperable, peer-to-peer networked, distributed Direct Digital Control System. The following communication protocols are acceptable:

1. ANSI/ASHRAE Standard 135 BACnet - A Data Communication Protocol for Building Automation and Control Networks
2. ANSI/TIA/EIA-568-B Commercial Building Telecommunications Cabling Standard
3. MODBUS Application Protocol V1.1b (applicable to factory packaged equipment controllers only)

B. The DDCS shall be comprised of:

1. Tridium Niagara\textsuperscript{AX} Vykon Supervisor S-AX-100 Windows 64-bit platform open network server with BACnet located at the Ops Center (by others)
2. Tridium Niagara\textsuperscript{AX} Vykon JACE J-700 open Building Automation Router Controller
3. Personal computers/devices with Web browser software
4. Routers
5. Repeaters
6. Equipment controllers (B-AAC, B-ASC, MEC)
7. Sensors (refer to Section 23 09 25)
8. Controlled devices (refer to Section 23 09 25)

C. The JACE shall connect to the Owner’s local or wide area network, depending on configuration. Access to the system, either locally in each building, or remotely shall be accomplished through standard Web browsers and/or the AX Supervisor, via the Internet and/or local area network.
D. Each JACE shall communicate to BACnet (B-AAC, B-ASC), and/or MODBUS (MEC) devices and/or other open protocol systems/devices as described on the contract drawings and/or in the specifications.

E. The DDCS shall be based on a Tridium Niagara® Vykon Framework. Provide an open automation infrastructure that integrates diverse systems and devices (regardless of manufacturer, communication standard or software) into a unified platform that can be easily managed in real time over the Internet using a standard Web browser.

F. BACnet controllers (B-AAC, B-ASC) shall connect to the JACE via a BACnet Local Network (MS/TP) (BLN). The BLN shall consist of a flat, open architecture utilizing ANSI/ASHRAE Standard 135 BACnet Protocol.

G. MODBUS Devices (MEC) shall connect to the NCE via a MODBUS Local Network (MLN). The MLN shall consist of a flat, open architecture utilizing MODBUS Application Protocol.

H. The basic control system includes all sensors, controllers, instruments, valves, actuators, devices, installation and service for a complete and functional control system. All control devices (valves, dampers, actuators, etc.) and associated power and control wiring shall be included. Refer to Section 23 09 47 Control Power and Wiring for HVAC. The DDCS shall be designed to allow easy field adjustment of all set points and parameters.

I. Provide 20% spare I/O in each panel system expansion to include monitoring of the access, intrusion detection, fire alarm, and lighting control systems as described in the specifications or shown on the drawings.

J. During the construction phase and prior to the owner moving in the building, provide a portable operator terminal for access to the DDCS. Refer to 2.5 F.

1.3 PROVIDER REQUIREMENTS

A. Manufacturer Qualifications

1. All products used in the installation shall be new, currently under manufacture, and shall be applied in standard off the shelf products. The installation shall not be used as a test site for any new products unless explicitly approved by the Engineer in writing. Provide JACE version upgrades for 5 years to maintain compatibility with the AX Supervisor at no additional cost to the owner.
B. Installer Qualifications

1. Installing Contractor shall have an established working relationship with Control System Manufacturer of not less than 5 years.
2. Installing Contractor and his Sub-Contractors shall have successfully completed manufacturer’s control system training. Provide certification of completed training, including hours of instruction and course outlines, with bid.
3. Installing Contractor shall have an office within 75 miles of the project site and provide 24 hour response in the event of a customer call, 7-days per week, 365 days per year.

1.4 APPROVED CONTROL SYSTEM MANUFACTURERS AND INSTALLING CONTRACTORS

A. The following control system manufacturers’ products that are certified by the BACnet Testing Laboratory are pre-qualified:

1. Delta Controls, Inc. DAC, DVC, DFC, and DNT BACnet Controllers
2. Siemens Building Technologies, Inc. TC and TEC BACnet Controllers
3. Honeywell International Spyder PUB and PVB BACnet Controllers
4. Tridium Niagara® AX Vykon JACE J-700, J-600E and J-234 Controllers
5. Schneider Electric – TAC I/A Series MNB BACnet Controllers
6. Carrier i-Vu Open Control System OPN BACnet Controllers
7. Distech Controls, Inc. ECB, RCB and PFC BACnet Controllers
8. Ingersoll Rand Tracer UC210, UC400, UC600 Controllers

B. The following Installing Contractors are pre-qualified:

1. Building Control Integrators
2. ASA Controls, Inc.
3. Innovative Energy Solutions, Inc.
4. Mechanical Systems of Dayton
5. Point To Point Systems
6. Habbegger Corporation
7. Waibel Energy Systems

1.5 CODES AND STANDARDS

A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities’ codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with the current editions of the following codes and standards:

1. National Electric Code (NEC)
2. Ohio Building Code (OBC) and Ohio Mechanical Code (OMC)
3. National Fire Protection Association (NFPA)
4. ANSI/ASHRAE Standard 55 Thermal Environmental Conditions For Human Occupancy
5. ANSI/ASHRAE Standard 62 Ventilation For Acceptable Indoor Air Quality
7. ANSI/ASHRAE Standard 135, BACnet - A Data Communication Protocol for Building Automation and Control Networks
8. FCC Regulation, Part 15

1.6 SYSTEM PERFORMANCE

A. Performance Standards. System shall conform to the following minimum standards over network connections:

1. Graphic Display. A graphic with 20 dynamic points/objects shall display with current data within 10 seconds.
2. Graphic Refresh. A graphic with 20 dynamic points/objects shall update with current data within 8 seconds.
3. Object Command. Devices shall react to command of a binary object within 2 seconds. Devices shall begin reacting to command of an analog object within 2 seconds.
4. Object Scan. Data used or displayed at a controller or workstation shall have been current within the previous 6 seconds.
5. Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 45 seconds.
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 second. Select execution times consistent with the mechanical process under control.
7. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per second. Select execution times consistent with the mechanical process under control.
8. Multiple Alarm Annunciation. Each workstation on the network shall receive alarms within 5 seconds of other workstations.
9. Reporting Accuracy. System shall report values with the minimum end-to-end accuracy listed in Table 1 of Section 23 09 25 Instrumentation and Control Devices.
10. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2 of Section 23 09 25 Instrumentation and Control Devices.

1.7 SUBMITTALS

A. Begin no work until submittals have been approved for conformity with design intent. Provide drawings as flash memory. When manufacturer's cutsheets apply to a product series rather than a specific product, clearly indicate applicable data by highlighting or by other means. Clearly reference covered specification and drawing on each submittal. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Provide submittals within 12 weeks after contract award, including the following:

1. Direct Digital Control System Hardware
a. Complete bill of materials indicating quantity, manufacturer, model number, and other technical data of equipment to be used.

b. Manufacturer's description and technical data such as performance curves, product specification sheets, and installation and maintenance instructions for items listed below and for relevant items not listed below:

1) Direct digital controllers
2) Transducers and transmitters
3) Sensors (including accuracy data)
4) Actuators
5) Valves
6) Dampers
7) Relays and switches
8) Control panels
9) Power supplies
10) Batteries
11) Operator interface equipment
12) Wiring

c. Wiring diagrams and layouts for each control panel.

d. Floor plan schematic diagrams indicating field sensor, controller and power supply locations.

2. Network Hardware and Software

a. Complete bill of material indicating quantity, manufacturer, model number, and relevant technical data of equipment used.

b. Manufacturer's description and technical data, such as product specifications and installation and maintenance instructions for items listed below and for relevant items furnished under this contract not listed below:

1) Central Processing Unit (CPU)
2) Power supply
3) Battery backup
4) Interface equipment between CPU and control panels
5) Routers
6) Repeaters
7) Operating System software
8) Operator interface software
9) Color graphic software
10) Third-party software

c. Schematic diagrams of control, communication, and power wiring for central system installation. Label cables and ports with computer manufacturers’ model numbers and functions. Show wiring to control system.

d. List of color graphics to be provided. Provide a conceptual layout of pictures and data for each graphic, showing or explaining which other graphics can be directly accessed.
3. Controlled Systems

a. Riser diagrams showing control network layout, communication protocol, and wire types.
b. Schematic diagram of each controlled system. Label control points/objects with point/object names. Graphically show locations of control elements.
c. Schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
d. Instrumentation list for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
e. Mounting, wiring, and routing plan view drawing in ¼ inch scale. Take into account HVAC, electrical and other systems’ design and elevation requirements. Show locations of concrete pads and bases and special wall bracing for panels to accommodate this work.
f. Complete description of control system operation including sequences of operation. Include and reference a schematic diagram of system.
g. Point/object list for each system controller including inputs and outputs (I/O), point/object numbers, controlled device associated with each I/O point/object, and location of I/O device. Indicate alarmed and trended points/objects.

4. Description of process, report formats, and checklists to be used in Part 3: “Control System Demonstration and Acceptance.”

5. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of BACnet controller (B-BC, B-AAC, B-ASC) and operator interface (B-OWS).

B. Schedules

1. Schedule of work provided within one month of contract award indicating:
   a. Intended sequence of work items
   b. Start date of each work item
   c. Duration of each work item
   d. Planned delivery dates for ordered material and equipment, and expected lead time
   e. Milestones indicating possible restraints on work by other trades or situations

2. Monthly written status reports indicating work completed and revisions to expected delivery dates. Include updated schedule of work.

C. Project Record Documents. Submit three copies of record (as-built) documents upon completion of installation for approval prior to final completion. Submittal shall consist of:

1. Project Record Drawings.
   a. As-built versions of the submittal shop drawings provided as flash memory.
b. Submittals to include complete electrical point-to-point wiring diagrams, component layouts, system and equipment component sequences of operation, start-up and checkout procedures. Include a list of all unit default safety and control settings, whether fixed or adjustable, as shipped from the factory. Where field modifications are required to meet the specification, provide all modification labor and materials, and submit a complete, detailed, step-by-step procedure for the modifications.

2. Testing and Commissioning Reports and Checklists. Completed versions checklists and trend logs used to meet requirements of Part 3: “Control System Demonstration and Acceptance.”

   a. As-built versions of the submittal product data.
   b. Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.
   c. Operator’s manual with procedures for operating control systems: logging on and off, handling alarms, producing point/object reports, trending data, overriding computer control, and changing setpoints and variables.
   d. Programming manual or set of manuals with description of the programming language and syntax of statements for algorithms and calculations used of point/object database creation and modification, of program creation and modification, and editor use.
   e. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points/objects, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
   f. Documentation of all programs created using custom programming language including setpoints, tuning parameters, and object database.
   g. Graphic files, programs and database on magnetic or optical media.
   h. List of recommended spare parts with part numbers and suppliers.
   i. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware, including computer equipment and sensors.
   j. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
   k. Licenses, guarantee, and warranty documents for equipment and systems.
   l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

4. Training Materials: Provide course outline and manuals for each class at least six weeks before the first class. Engineer will modify course outlines and manuals if necessary to meet Owner’s needs. Engineer will review and approve course outlines and manuals at least three weeks before first class.

1.8 WARRANTY
A. Warrant all work as follows:

1. Warrant labor and materials for specified control system free from defects for a period of 18 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner. Respond during Owner’s business hours within 24 hours of Owner’s warranty service request.

2. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.

3. If Engineer determines that equipment and systems operate satisfactorily at the end of the final start-up, testing, and commissioning phase, Engineer will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.

4. Provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware which resolve Contractor identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above mentioned items. Do not install updates or upgrades without Owner’s written authorization.

1.9 OWNERSHIP OF PROPRIETARY MATERIAL

A. Project specific software and documentation shall become Owner’s property. This includes, but is not limited to:

1. Graphics
2. Record drawings
3. Database
4. Application programming code
5. Documentation

B. It is the Owner’s express goal to implement an open system that will allow products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the JACE, AX Supervisor, and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the Owner. The Owner shall determine which organizations to be named in the SI organization ID (“orgid”) of all software licenses. Owner shall be free to direct the modification of the “orgid” in any software license, regardless of supplier, by Tridium Inc.

PART 2 - PRODUCTS
2.1 MATERIALS

A. The equipment specified shall be provided as defined herein, shown on the drawings and as required to accomplish the sequence of control.

B. Use new products that the manufacturer is currently manufacturing and that have been installed in a minimum of 25 installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner or Owner’s Representative. Spare parts shall be available for at least five-years after completion of this contract.

2.2 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

A. Provide a peer-to-peer networked, stand-alone, distributed control system with that integrates BACnet, MODBUS, OPC, and other open communication protocols in one open, interoperable system.

B. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs.

2.3 NETWORKS

A. The Local Area Network (LAN) shall be a 100 Mbs Ethernet network supporting BACnet, Java, XML, HTTP, and SOAP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple JACEs.

2.4 BACNET CONTROLLERS

A. Controllers shall be microprocessor based interoperable BACnet Advanced Application Controllers (B-AAC) or Application Specific Controllers (B-ASC). B-AAC controllers shall be used for air handling units and plant controls. B-AAC or B-ASC controllers shall be used for other applications, such as, fan coil units, blower coil units, VAV, or other equipment as required by the application. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals. The system supplier must provide a PICS document for each type of controller. Controllers for AH units and central equipment (chillers, boilers, etc.) shall be equipped with display screens.

B. The B-AAC and B-ASC controllers shall communicate with the JACE via an ETHERNET (BACnet/IP) connection or via the EIA-485 (BACnet MSTP) connection.

C. Provide documentation for each B-AAC and/or B-ASC with the following information at minimum:

1. BACnet Device; MAC address, name, type and instance number
2. BACnet Objects; name, type and instance number

2.5 OPERATOR INTERFACE
A. Operator Interface. Users, based on access profile, shall be able to interface to the DDCS via a standard web browser, VPN and/or AX Supervisor via an Ethernet LAN or remotely over the Internet.

B. Operator Functions. Operator interface shall allow each authorized operator to execute the following functions as a minimum:

1. Log In and Log Out. System shall require user name and password to log in to operator interface.
2. Point-and-click Navigation. Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.
3. View and Adjust Equipment Properties. Operators shall be able to view controlled equipment status and to adjust operating parameters such as setpoints, PID gains, on and off controls, and sensor calibration.
4. View and Adjust Operating Schedules. Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.
5. View and Respond to Alarms. Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms.
6. View and Configure Trends. Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points.
7. View and Configure Reports. Operators shall be able to run preconfigured reports, to view report results, and to customize report configuration to show data of interest.
8. Manage Control System Hardware. Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.
9. Manage Operator Access. Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit operator function authorization. Operator shall be able to authorize each operator function separately.

C. Graphics

1. Provide and use Tridium Niagara AX Vykon graphics presentation framework and graphics development tool. Provide browser-based displays that support both rich client displays that support Java plug-ins, plus pure thin client displays that support only HTML and JavaScript. Create displays for a wide range of devices including PC’s, PDA’s and smart phones. Automatically generate navigation trees and include an extensive library of graphic elements.
2. System Graphics. The operator workstation software shall be graphically oriented. The system shall allow display of up to 10 dynamic and animated graphic screens at once.
for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while on-line. An operator with the proper password level shall be able to add, delete, or change dynamic objects on a graphic. Dynamic objects shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation by shifting image files based on the status of the object.

3. Custom Graphics. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system that uses the mouse to create and modify graphics in industry standard formats. The graphics generation package also shall provide the capability of capturing or converting graphics from other programs such as Visio or AutoCAD.

a. Operator interface shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.

1) Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
2) Animation. Graphics shall be able to animate by displaying different image files for changed object status.
3) Floor plans. Provide detailed floor plans showing each piece of equipment, control zoning and space temperatures (green if within setpoint range; red if out of setpoint range), and all alarm points.
4) Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
5) Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).

b. Graphics Library. Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program. Graphics shall be created by drag-and-drop selection of graphic symbols and drag-and-link with BACnet objects with dynamic and interactive display fields.

4. Multilingual. Software shall be supported in the following languages English, Spanish, French, German, Chinese.
5. Dynamic Data Exchange (DDE). Software shall support dynamic data sharing with other Windows-based programs for third party add-on functionality e.g. preventative maintenance, tenant billing, etc.

D. System Applications. Each JACE-700 shall provide operator interface and off line storage of system information. Provide the following applications at each JACE:

1. Automatic System Database Save and Restore. Each workstation shall store on the hard disk a copy of the current database of each NCE. This database shall be updated whenever a change is made in any system panel. The storage of these data shall be automatic and not require operator intervention. In the event of a database loss in a building management panel, the first workstation to detect the loss shall automatically restore the database for that panel. This capability may be disabled by the operator.

2. Manual Database Save and Restore. A system operator with the proper password clearance shall be able to save the database from any system panel. The operator shall be able to clear a panel database via the network and manually initiate a download of a specified database to any panel in the system from the network.

3. System Configuration. The workstation and web server software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password protection. Each workstation and web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.

4. On-Line Help. Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.

5. Security. Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. Each user name and password combination shall define accessible viewing, editing, adding, and deleting functions in each system application, editor, and object. The system supervisor shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the functions accessible to viewing and/or changing each system application, editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto logoff time period shall be user-adjustable. All system security data shall be stored in an encrypted format.

6. System Diagnostics. The system shall automatically monitor the operation of all workstations, web servers, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator. System shall automatically monitor controller and I/O point operation. System shall annunciate controller failure and I/O point locking (manual overriding to a fixed value).

7. Alarm Processing. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, alarm limit differentials, states, and reactions for each object in the system. Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
8. Alarm Messages. Alarm messages shall use the English language descriptor for the object in alarm, in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying upon acronyms or other mnemonics.

9. Alarm Reactions. The operator shall be able to determine (by object) what if any actions are to be taken during an alarm. Actions shall include logging, printing, starting programs, send email, displaying messages, dialing out to remote stations, paging, providing audible annunciation, or displaying specific system graphics. Each of these actions shall be configurable by workstation and time of day.

10. Trend Logs. The operator shall be able to define a custom trend log for any data object in the system. This definition shall include change-of-value digital, change-of-value analog, time interval, start time, and stop time. Trend data shall be sampled and stored on the NCE or server and be archived on the hard disk and be retrievable for use in spreadsheets and standard database programs. Trends shall be BACnet trend objects.

11. Alarm and Event Log. The operator shall be able to view all system alarms and change of states from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms. All that have not been cleared by the operator shall be archived to the hard disk on the workstation.

12. Object and Property Status and Control. Provide a method for the operator to view, and edit if applicable, the status of any object and property in the system. The status shall be available by menu, on graphics, or through custom programs.

13. Clock Synchronization. The real-time clocks in all building control panels and workstations shall use the BACnet Time Synchronization service. The system also shall be able to automatically synchronize all system clocks daily from any operator-designated device in the system. The system shall automatically adjust for daylight savings and standard time, if applicable.

14. Reports and Logs. Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval, and date. Report data shall be achievable on the hard disk for historical reporting. Provide the ability for the operator to obtain real-time logs of all objects by type or status (e.g., alarm, lockout, normal). Reports and logs shall be stored on the PC hard disk in a format that is readily accessible by other standard software applications, including spreadsheets and word processing. Reports and logs shall be readily printed to the system printer and shall be set to be printed either on operator command or at a specific time each day.

15. Standard Reports. The following standard system reports shall be provided for this project. Provide ability for the owner to readily customize these reports for this project.

a. All Objects: All system (or subsystem) objects and their current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.

b. Alarm Summary: All current alarms (except those in alarm lockout).

c. Disabled Objects: All objects that are disabled.

d. Alarm Lockout Objects: All objects in alarm lockout (whether manual or automatic).
e. Alarm Lockout Objects in Alarm: All objects in alarm lockout that are currently in alarm.

f. Logs:

1) Alarm History
2) System Messages
3) System Events
4) Trends
5) Operator Activity. At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.

16. Custom Reports. Provide the capability for the operator to easily define any system data into a daily, weekly, monthly, or annual report. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. These reports shall be time and date stamped and shall contain a report title and the name of the facility.

17. Electrical, Gas, and Weather Reports

a. Weather Data Report: Provide a monthly report showing the daily minimum, maximum, and average outdoor air temperature, as well as the number of heating and cooling degree-days for each day. Provide an annual (12-month) report showing the minimum, maximum, and average outdoor air temperature for the month, as well as the number of heating and cooling degree-days for the month.

b. Electrical Meter Report: Provide a monthly report showing the daily electrical consumption and peak electrical demand with time and date stamp for each building meter. Provide the ability to monitor separate meter (future) for lighting panel.

c. Provide an annual (12-month) summary report showing the monthly electrical consumption and peak demand with time and date stamp for each meter.

d. Gas Meter Report: Provide a monthly report showing the daily natural gas consumption for each meter. Provide an annual (12-month) report that shows the monthly consumption for each meter.

e. Water meter report: Provide a monthly report showing the daily water consumption for each meter. Provide an annual (12-month) report that shows the monthly consumption for each meter.

E. Workstation Applications Editors. Each PC workstation shall support editing of all system applications. Provide editors for each application at the PC workstation. The applications shall be downloaded and executed at one or more of the controller panels.

1. Controller. Provide a full-screen editor for each type of application that shall allow the operator to view and change the configuration, name, control parameters, and setpoints for all controllers.
2. Scheduling. An editor for the scheduling application shall be provided at each workstation. Provide a method of selecting the desired schedule and month. This shall consist of a monthly calendar for each schedule. Exception schedules and holidays

10. Local Monitoring. Provide a local monitoring station to view the status of all controllers. Provide an operator interface to view system data and alarm status.
shall be shown clearly on the calendar. Provide a method for allowing several related objects to follow a schedule. The start and stop times for each object shall be adjustable from this master schedule. Schedules shall be easy to copy to other objects and/or dates.

3. Custom Application Programming. Provide the tools to create, modify, debug, and download custom application programming. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom routines are edited, compiled, and downloaded. The programming language shall have the following features:

a. The language shall be English language oriented, be based on the syntax of BASIC, FORTRAN, C, or PASCAL, and allow for free-form programming (i.e., not column-oriented or "fill in the blanks"). Alternatively, the programming language can be graphically based using function blocks as long as blocks are available that directly provide the functions listed below and that custom or compound function blocks can be created.

b. A full-screen character editor/programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete custom programming code. It also shall incorporate word processing features such as cut/paste and find/replace.

c. The programming language shall allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.

d. The editor/programming environment shall have a debugging/simulation capability that allows the user to step through the program and observe any intermediate values and/or results. The debugger also shall provide error messages for syntax and execution errors.

e. The programming language shall support conditional statements (IF/THEN/ELSE/ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

f. The programming language shall support floating point arithmetic using the following operators: +, -, /, x, square root, and x-to-the-y-power. The following mathematical functions also shall be provided: natural log, log, trigonometric functions (sine, cosine, etc.), absolute value, and minimum/maximum value from a list of values.

g. The programming language shall have predefined variables that represent time of day, day of the week, month of the year, and the date. Other predefined variables shall provide elapsed time in seconds, minutes, hours, and days. These elapsed time variables shall be able to be reset by the language so that interval-timing functions can be stopped and started within a program. Values from all of the above variables shall be readable by the language so that they can be used in a program for such purposes as IF/THEN comparisons, calculations, etc.

h. The language shall be able to read the values of the variables and use them in programming statement logic, comparisons, and calculations.

i. The programming language shall have predefined variables representing the status and results of the System Software and shall be able to enable, disable, and change the setpoints of the System Software described below.
j. The programs shall support online changes with the ability to read real-time values without exiting the program. Sample programs and syntax help functions shall be resident in the program.

F. Portable Operator's Terminal. Furnish a Portable Operator's Terminal that shall be capable of accessing all system data. This device may be connected to any point on the system network or may be connected directly to any controller for configuration, programming, setup, and troubleshooting. Include on any manufacturer specific software for setup and configuration of B-AAC and B-ASC controllers. This device may be connected to any point on the system network or it may be connected directly to controllers using the BACnet PTP (Point-To-Point) Data Link/Physical layer protocol. The terminal shall use the Read (Initiate) and Write (Execute) Services of ASHRAE Standard 135, to communicate with BACnet objects in the internetwork. The Portable Operator's Terminal shall be an IBM compatible tablet-style PC including all software and hardware required. The tablet shall contain at minimum:

1. 2.13 GHz Intel Dual Core Processor
2. 1 GB RAM
3. 15.6 inch LCD touchscreen, 1.05 Megapixels resolution
4. Full Adobe® Flash® enabled
5. Micro USB, RS-232 and Micro HDMI ports
6. Wi-Fi 802.11 a / b / g / n connectivity
7. Windows operating system

2.6 CONTROLLER SOFTWARE

A. Local system control shall be performed by a field programmable Direct Digital Controller microprocessor based, which incorporates Direct Digital Control, and all necessary energy management functions. Field programming shall be via a user programmable software package which allows the user (programmer) to write unique programs thru the local operators terminal. Digital Control Systems which require off site software development or which are not programmable (burned in sequences) are not acceptable.

B. The Direct Digital Controller shall perform its assigned control and energy management functions as a stand-alone unit, however it shall be incorporated into a DDCS local network (BACnet, MODBUS) for communication with local or remote operator workstations, web browsers, or servers. The digital controller shall perform its full control and energy management functions, regardless of the condition of communications link with local or remote operator workstations, web browsers, or servers. In addition, when more than one digital controller is required to meet these specifications, the digital control system shall be capable of sharing information between digital controllers to develop complex strategies and common point sensing. Permanently connect all controllers and system equipment displays, computers, modems, routers, etc., together via a communications network for a complete and interoperable system.

C. Energy Management. The DDCS shall have software capable of performing all the energy management functions necessary to reduce energy consumption. These programs include, but are not limited to: supply air reset using space load demand, enthalpy
economizer control, supply water reset, optimal start using an adaptive algorithm to prevent the need for manual adjustment of parameters.

D. Owner tailored programs. A library of routines shall be resident in the digital control system, capable of generating additional programs thru the local program terminal as may be required for specified owner requirements. These include, in part: demand control, intermediate season (dead zone) control, variable air volume fan matching and supply fan control, trending of variables, historical data storage (60 values for 30 changes of value minimum), totalizing, holiday programming.

E. Furnish the following applications software for building and energy management. All software applications shall reside and operate in the system controllers. Editing of applications shall occur at the operator workstation.

F. System Security

1. User access shall be secured using individual security passwords and user names.
2. Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.
3. User Log On/Log Off attempts shall be recorded.
4. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.

G. Scheduling. Provide the capability to schedule each object or group of objects in the system. Each schedule shall consist of the following:

1. Weekly Schedule. Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop, optimal start and night economizer. Each schedule may consist of up to 10 events. When a group of objects are scheduled together, provide the capability to adjust the start and stop times for each member.
2. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to one year in advance. Once an exception schedule is executed, it will be discarded and replaced by the standard schedule for that day of the week.
3. Holiday Schedules. Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.

H. System Coordination. Provide a standard application for the proper coordination of equipment. This application shall provide the operator with a method of grouping together equipment based on function and location. This group may then be used for scheduling and other applications.

I. Binary Alarms. Each binary object shall be set to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
J. Analog Alarms. Each analog object shall have both high and low alarm limits. Alarming must be able to be automatically and manually disabled.

K. Alarm Reporting. The operator shall be able to determine the action to be taken in the event of an alarm. Alarms shall be routed to the appropriate workstations based on time and other conditions. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages, and display graphics.

L. Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms. The system shall have the ability to dial out in the event of an alarm using BACnet Point-To-Point at a minimum of 56K baud. Receivers shall be BACnet workstations.

M. Maintenance Management. The system shall monitor equipment status and generate maintenance messages based upon user-designated run-time, starts, and/or calendar date limits.

N. Sequencing. Provide application software based upon the sequences of operation specified to properly sequence chillers, boilers, and pumps.

O. PID Control. A PID (proportional-integral-derivative) algorithm with direct or reverse action and anti-windup shall be supplied. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, setpoint, and PID gains shall be user-selectable.

P. Staggered Start. This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts, shall be user-selectable.

Q. Energy Calculations.
   1. Provide software to allow instantaneous power (e.g., kW) or flow rates (e.g., L/s GPM) to be accumulated and converted to energy usage data.
   2. Provide an algorithm that calculates a sliding-window average (e.g., rolling average). The algorithm shall be flexible to allow window intervals to be user specified (e.g., 15-minutes, 30-minutes, 60-minutes).
   3. Provide an algorithm that calculates a fixed-window average. A digital input signal shall define the start of the window period (e.g., signal from utility meter) to synchronize the fixed window average with that used by the utility.

R. Anti-Short Cycling. All binary output objects shall be protected from short cycling. This feature shall allow minimum on-time and off-time to be selected.

S. On/Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and setpoint. The algorithm shall be direct-acting or reverse-acting, and incorporate an adjustable differential.
T. Run-time Totalization. Provide software to totalize run-times for all binary objects. A high run-time alarm shall be assigned, if required, by the operator.

U. Demand-Controlled Ventilation. Provide a program to adjust the quantity of outdoor ventilation air supplied to a zone by a central air handling unit based on the ventilation rate required to provide adequate indoor air quality in accordance with ASHRAE Standard 62.

2.7 BACNET BUILDING CONTROLLER (B-BC)

A. General. Provide an adequate number of BACnet Building Controllers (B-BC) to achieve the performance specified in the Part 1 Article on “System Performance.” BACnet Building Controllers shall be Tridium NiagaraAX Vykon JACE-700 open controllers. Each of these panels shall meet the following requirements.

1. The Building Automation System shall be comprised of one or more independent, standalone, microprocessor-based building controllers to manage the global strategies described in the System Software section.

2. The building controller shall have sufficient memory to support its operating system, database, and programming requirements.

3. Data shall be shared between networked building controllers.

4. The operating system of the building controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information, and allow central monitoring and alarms.

5. Controllers that perform scheduling shall have a real-time clock.

6. The building controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall

   a. Assume a predetermined failure mode,

   b. Generate an alarm notification.

7. The building controller shall communicate with other BACnet devices on the internetwork using the Read (Execute and Initiate) and Write (Execute and Initiate) Property services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE Standard 135-2007.

<table>
<thead>
<tr>
<th>Building Controller BACnet Services</th>
<th>Initiate</th>
<th>Execute</th>
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</thead>
<tbody>
<tr>
<td>Acknowledge Alarms</td>
<td>--</td>
<td>x</td>
</tr>
<tr>
<td>Confirmed COV Notification</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Confirmed Event Notification</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Get Alarm Summary</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Get Enrollment Summary</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Subscribe COV</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Unconfirmed COV Notification</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Unconfirmed Event Notification</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Atomic Read File</td>
<td>--</td>
<td>x</td>
</tr>
<tr>
<td>Atomic Write File</td>
<td>--</td>
<td>x</td>
</tr>
<tr>
<td>Add List Element</td>
<td>--</td>
<td>x</td>
</tr>
<tr>
<td>Function</td>
<td>Available</td>
<td></td>
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<td>----------------------------------</td>
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<tr>
<td>Remove List Element</td>
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<tr>
<td>Create Object</td>
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<td>Delete Object</td>
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<td>Read Property Multiple</td>
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<td>Write Property</td>
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<td>Read Range</td>
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<td>Write Property Multiple</td>
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<td>Device Communication Control</td>
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<td>Confirmed Private Transfer</td>
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<td>Unconfirmed Private Transfer</td>
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<tr>
<td>Reinitialize Device</td>
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<td></td>
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<tr>
<td>Time Synchronization</td>
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<td></td>
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<tr>
<td>Who-Has</td>
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<tr>
<td>I-Have</td>
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<td>Who-Is</td>
<td>x</td>
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<tr>
<td>I-Am</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

8. BACnet Functional Groups. The Building Controller shall support the following BACnet functional groups: Clock, Event Initiation, COV Event Response, Files, Device Communication and Time Master.

B. Communication

1. Each building controller shall reside on a BACnet network using the ISO 8802-3 (Ethernet) Data Link/Physical layer protocol. Each building controller also shall perform BACnet routing if connected to a network of advanced application and application specific controllers.

2. The controller shall provide a service communication port using BACnet Data Link/Physical layer protocol for connection to a portable operator’s terminal.

C. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at 0 degrees C to 65 degrees C [32 degrees F to 150 degrees F] and 10 to 90 percent RH.

2. Controllers used in conditioned space shall be mounted in dust proof enclosures, and shall be rated for operation at 0 degrees C to 50 degrees C [32 degrees F to 120 degrees F].

D. Keypad. A local keypad and display shall be provided for each controller. The keypad shall be provided for interrogating and editing data. An optional system security password shall be available to prevent unauthorized use of the keypad and display. If the manufacturer does not provide this keypad and display, provide a portable operator terminal.

E. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
F. Memory. The building controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

G. Immunity to power and noise. Controller shall be able to operate at 90 percent to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m [3 ft].

2.8 MODBUS System Integration

A. The JACE shall support the integration of device data from MODBUS RTU, ACSII, or TCP control system devices. The connection to the MODBUS system shall be via an RS-232, RS485, or Ethernet IP as required by the device.

1. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of the MODBUS system data into the FPMS. Objects provided shall include at a minimum:
   2. Read/Write MODBUS AI Registers
   3. Read/Write MODBUS AO Registers
   4. Read/Write MODBUS BI Registers
   5. Read/Write MODBUS BO Registers

B. All scheduling, alarming, logging and global supervisory control functions, of the MODBUS system devices, shall be performed by the Network Area Controller.

C. The DDCS supplier shall provide a MODBUS system communications driver. The equipment system vendor that provided the equipment utilizing MODBUS shall provide documentation of the system’s MODBUS interface and shall provide factory support at no charge during system commissioning.

2.9 INPUT/OUTPUT INTERFACE

A. Hardwired inputs and output points/objects may be wired into the system through building, advanced application, or application specific controllers.

B. All input and output points shall be protected such that shorting of the point to itself, to another point, or to ground, shall cause no damage to the controller. All input and output points shall be protected from voltage up to 24 volts of any duration, such that contact with this voltage will cause no damage to the controller.

C. Binary inputs shall allow the monitoring of ON/OFF signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense “dry contact” closure without external power (other than that provided by the controller) being applied.

D. Pulse accumulation input objects. This type of object shall conform to all the requirements of binary input objects and also accept up to 10 pulses per second for pulse accumulation.
E. Analog inputs shall allow the monitoring of low-voltage (0-10 VDC), current (4-20 mA), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with – and field configurable to – commonly available sensing devices.

F. Binary outputs shall provide for ON/OFF operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on building and custom application controllers shall have three-position (On/Off/Auto) override switches, and status lights. Outputs shall be selectable for either normally open or normally closed operation.

G. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 VDC signal or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs on building or custom application controllers shall have status lights and a two-position (AUTO/MANUAL) switch and manually adjustable potentiometer for manual override. Analog outputs shall not exhibit a drift of greater than 0.4 percent of range per year.

H. Tri-State Outputs. Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Use of three-point floating devices shall be limited to zone control and terminal unit control applications (VAV terminal units, duct mounted heating coils, zone dampers, radiation, etc.) Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

I. Input/Output points shall be universal type, i.e., controller input or output may be designated (in software) as either a binary or analog type point with appropriate properties. Application specific controllers are exempted from this requirement.

J. System Object Capacity. The system size shall be expandable to at least twice the number of input/output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.

K. Each controlled device or function shall be a separate output of the digital controller (i.e., Economizer, Heating Valve, Cooling Valve are three (3) separate output points). When a points’ list is provided the greater number of points and their configuration shall govern. Multiplexers or programmable logic controllers utilized with digital controller input and output points to expend the digital controller I/O capabilities will not be allowed.

L. Refer to section 23 09 25 Instrumentation and Control Devices for HVAC. PART 3 - EXECUTION

3.1 EXAMINATION

A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.
B. Inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

C. Examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate or if any discrepancies occur between the plans and the Contractor’s work and the plans and the work of others, then report these discrepancies to the Engineer and obtain written instructions for any changes necessary to accommodate the temperature control work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect to report such discrepancies shall be made by and the costs borne by this Contractor.

3.2 PROTECTION

A. Protect all work and material from damage by his work or employees, and shall be liable for all damage thus caused.

B. The installing contractor shall be responsible for his work and equipment until finally inspected, tested, and accepted. Protect any material that is not immediately installed. Close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 COORDINATION

A. Site

1. Where the temperature control work will be installed in close proximity to, or will interfere with work of other trades, assist in working out space conditions to make a satisfactory adjustment. If temperature control work is installed before coordinating with other trades, so as to cause any interference with work of other trades, the temperature control work shall be re-worked to correct the condition without extra charge.

2. Coordinate and schedule work with all other work in the same area, or with work which is dependent upon other work, to facilitate mutual progress.

B. Test and Balance

1. Furnish all tools necessary to interface to the control system for test and balance purposes.

2. Provide training in the use of these tools. This training will be planned for a minimum of 4 hours.

3. In addition provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.
4. The tools used during the test and balance process will be returned at the completion of the testing and balancing.

C. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated as follows:

1. All communication media and equipment shall be provided as specified in Part 2: “Communication” of this specification.
2. Each supplier of controls product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequences of operation described in this section.
3. Coordinate and resolve any incompatibility issues that arise between the control products provided under this Section and those provided under other sections or divisions of this specification.

D. Revise equipment tagging and nomenclature, room numbering, etc. to reflect as-built conditions or an Owner’s preference for integration into his existing naming numbering convention.

3.4 FIELD QUALITY CONTROL

A. All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this specification.

B. Continually monitor the field installation for code compliance and quality of workmanship.

C. Have work inspected by authorities having jurisdiction over the work.

3.5 CONTROLLERS

A. Provide a separate controller for each AHU or other HVAC system.

B. Building Controllers and Custom Application Controllers shall be selected to provide a minimum of 15 percent spare I/O point/object capacity for each point/object type found at each location. If input /objects are not universal, 15 percent of each type is required. If outputs are not universal, 15 percent of each type is required. A minimum of one spare is required for each type of point/object used.

1. Future use of spare capacity shall require providing the field device, field wiring, point/object database definition, and custom software. No additional controller boards or point/object modules shall be required to implement use of these spare points.

3.6 PROGRAMMING

A. Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25 percent of available memory free for future use.
B. Point/object Naming: System point/object names shall be modular in design, allowing easy operator interface without the use of a written point/object index. Use the following naming convention:

```
AAA BBB CCC DDEEE
```

where:

AAA is used to designate the location of the point/object within the building such as mechanical room, wing, or level, or the building itself in a multi-building environment.

BBB is used to designate the mechanical system with which the point/object is associated (e.g., A01, HTG, CLG, LTG).

CCC represents the equipment or material referenced (e.g., SAF for supply air fan, EXF for exhaust fan, RAF for return air fan).

D or DD or DDD may be used for clarification or for identification if more than one of CCC exists (e.g., SAF10, EXF121).

EE represents the action or state of the equipment or medium (e.g., T for temperature, RH for humidity, CO for control, S for status, D for damper control, I for current).

C. Software Programming

1. Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system, but not specified in this document, also shall be provided. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:

   a. Text-based:
      
      1) Must provide actions for all possible situations
      2) Must be modular and structured
      3) Must be commented

   b. Graphic-based
      
      1) Must provide actions for all possible situations
      2) Must be documented

   c. Parameter-based
      
      1) Must provide actions for all possible situations
      2) Must be documented

2. After submittal and review of control software, offer to schedule a meeting with the Engineer and Commissioning Agent (CxA) to review system function.
3. Alarms. Setup alarms for each temperature, humidity, pressure, and CO2 analog type sensor that indicate when the sensed media is operating outside the normal range. Setup alarms for binary type safety type switches such as low temperature cutouts, high or low static pressure cutouts, etc. Setup alarms for equipment fault (diagnostic and critical) alarms. The alarms shall be indicated on the systems and equipment graphic screens, and recorded in an alarm event report.

4. Trends. Setup trends for analysis of heating and cooling operations of air handling systems, heating systems and cooling systems. Include status of fans, pumps, and compressors; positions of dampers, and valves; enable/disable modes of operation, such as, system, economizer, warmup, setback, setup, occupied, standby, unoccupied, lead, heating, and cooling; analog sensor values temperature, humidity, pressure, CO2, and enthalpy.

D. Operator Interface

1. Standard Graphics. Provide graphics for all controlled systems and floor plans of the building. Point/object information on the graphic displays shall dynamically update. Show on each graphic all input and output points/objects for the system. Also show relevant calculated points/objects such as setpoints.

2. Show terminal equipment information on a “graphic” summary table. Provide dynamic information for each point/object show.

3. Provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and their functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.

3.7 CONTROL SYSTEM CHECKOUT AND TESTING

A. Start-up Testing: All testing listed in this article shall make up part of the necessary verification of an operating control system. This testing shall be completed before the Owner’s Representative is notified of the system demonstration.

1. Upon completion of the control system, adjust all components of the system. Make all adjustments in the control system required and as directed by the balancer to achieve the desired air balance quantities. All instruments shall be carefully calibrated and each control function shall be demonstrated to function properly, to the satisfaction of the Engineer and the Owner. Provide a complete instruction manual covering the function and operation of all components. At the time of demonstration, each function shall be simulated to ensure that controls respond properly to all signals, and the Owner shall be instructed in the proper operation of the system.

2. Furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.

3. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.

4. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures per manufacturers’ recommendations.
5. Verify that all binary output devices (relays, solenoid valves, two position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.

6. Verify that all analog output devices (transducers, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. Check all control valves and automatic dampers to ensure proper action and closure. Make any necessary adjustments to valve stem and damper blade travel.

7. Verify that the system operation adheres to the Sequences of Operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimum Start/Stop routines.

8. Alarms and Interlocks
   
   a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
   b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
   c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

9. Each unit and associated controls, safeties and wiring shall be checked out, started and adjusted by a factory trained service technician. Submit a startup report including a list of all unit safety and control settings, whether fixed or adjustable, as field checked and setup per the specified design conditions five days after unit startup. Submit service technician certification upon request.

3.8 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration

1. Prior to commissioning and acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the temperature controls have been completed, started up and performed its own tests.

2. The tests described in this section are to be performed in addition to the tests that are performed as a necessary part of the installation, startup, and debugging process and as specified in the “Control System Checkout and Testing” Article in Part 3 of this specification. The Engineer may be present to observe and review these tests. The Engineer shall be notified at least 10 days in advance of the start of the testing procedures.

3. The demonstration process shall follow that approved in Part 1: “Submittals.” The approved checklists and forms shall be completed for all systems as part of the demonstration.

4. Provide at least two persons equipped with two way communication, and demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point/object and system. Provide and operate any test equipment required to prove the proper operation.
5. Trend log every point/object for one month continuous operation following demonstration period. Review report and correct any operational deficiencies and submit correction report and trend logs for record purposes. Also, submit to the Commissioning Agent for their review, prior to start of Commissioning.

6. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.


8. Demonstrate compliance with Sequences of Operation through all modes of operation.


10. Additionally, the following items shall be demonstrated:

   a. DDC Loop Response. Supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in setpoint, which represents a change of actuator position of at least 25 percent of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the setpoint, actuator position, and controlled variable values. Further tune any loop that yields unreasonably under-damped or over-damped control.

   b. Optimum Start. Supply a trend data output showing the capability of the algorithm. The hour by hour trends shall include the output status of all optimally started equipment, as well as temperature sensor inputs of affected areas.

   c. Interface to the building fire alarm system.

   d. Operational logs for each system that indicate all setpoints, operating points, valve positions, mode, and equipment status shall be submitted to the Engineer. These logs shall cover three 48 hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.

11. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date, and any necessary repairs or revisions to the hardware or software to successfully complete all tests shall be made.

B. Acceptance

1. All tests described in this specification shall have been performed to the satisfaction of both the Engineer and Owner prior to the acceptance of the control system as meeting the requirements of Completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the Completion requirements if stated as such in writing by the Engineer. Such tests shall then be performed as part of the warranty.

2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1: Submittals.

C. During the first year of operation, after acceptance by the Owner, provide complete service to adjust or assist the Owner in adjusting the equipment to obtain optimum performance from the control equipment and from the heating and air conditioning systems in general. This shall be done without additional expense to the Owner. This work shall include
revisions to DDC software programs and controller, and all PC front end software upgrades. All software shall be provided to the Owner in disk form, including back-ups of final field programs.

3.9 CLEANING

A. Clean up all debris resulting from its activities daily. Remove all cartons, containers, crates, etc., under its control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.

B. At the completion of work in any area, clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.10 TRAINING

A. Provide a minimum of five onsite training classes 4 hours in length during the construction period for personnel designated by the owner.

B. Provide two additional training sessions at 6 and 12 months following building’s turnover. Each session shall be 8 hrs. in length and must be coordinated with the building Owner.

C. Owner training items to include all MEP/T systems, minimum of 4 hours.

D. Train the designated staff of Owner’s Representative and Owner to enable them to:

1. Day-to-day Operators:

   a. Proficiently operate the system
   b. Understand control system architecture and configuration
   c. Understand DDC system components
   d. Understand system operation, including DDC system control and optimizing routines (algorithms)
   e. Operate the workstation and peripherals
   f. Log on and off the system
   g. Access graphics, point/object reports, and logs
   h. Adjust and change system setpoints, time schedules, and holiday schedules
   i. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
   j. Understand system drawings, and Operation and Maintenance manual
   k. Understand the job layout and location of control components
   l. Access data from DDC controllers
   m. Operate portable operator's terminals
2. Advanced Operators:

   a. Make and change graphics on the workstation
   b. Create, delete, and modify alarms, including annunciation and routing of these
   c. Create, delete, and modify point/object trend logs, and graph or print these
   d. Create, delete, and modify reports
   e. Add, remove, and modify system’s physical points/objects
   f. Create, modify, and delete programming
   g. Add panels when required
   h. Add operator interface stations
   i. Create, delete, and modify system displays — both graphical and otherwise
   j. Perform DDC system field checkout procedures
   k. Perform DDC controller unit operation and maintenance procedures
   l. Perform workstation and peripheral operation and maintenance procedures
   m. Perform DDC system diagnostic procedures
   n. Configure hardware including PC boards, switches, communication, and I/O points/objects
   o. Maintain, calibrate, troubleshoot, diagnose, and repair hardware
   p. Adjust, calibrate, and replace system components

3. System Managers/Administrators:

   a. Maintain software and prepare backups
   b. Interface with job-specific, third-party operator software
   c. Add new users and understand password security procedures

E. Provide course outline and materials as per “Submittals” Article in Part 1 of this specification. The instructor(s) shall provide one copy of training material per student.

F. The instructor(s) shall be factory-trained instructors experienced in presenting this material.

G. Classroom training shall be done using a network of working controllers representative of the installed hardware.

3.11 IN ADDITION TO THE ADJUSTMENTS AND FINE TUNING, INCLUDE AS A PART OF THIS CONTRACT THE EQUIVALENT OF FIVE (5) MAN DAYS OF SERVICE TECHNICIAN TIME FOR WORK AS MAY BE SPECIFIED BY THE ENGINEER.

END OF SECTION 23 09 23
1.1 SUMMARY

A. Section includes control valves and actuators for DDC systems.

B. Related Requirements:
   1. Section 230923 "Direct-Digital Control System for HVAC" control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Include diagrams for power, signal, and control wiring.
   2. Include diagrams for pneumatic signal and main air tubing.

C. Delegated-Design Submittal:
   1. Schedule and design calculations for control valves and actuators, including the following:
      a. Flow at project design and minimum flow conditions.
      b. Pressure differential drop across valve at project design flow condition.
      c. Maximum system pressure differential drop (pump close-off pressure) across valve at project minimum flow condition.
      d. Design and minimum control valve coefficient with corresponding valve position.
      e. Maximum close-off pressure.
      f. Leakage flow at maximum system pressure differential.
      g. Torque required at worst case condition for sizing actuator.
      h. Actuator selection indicating torque provided.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to size products where indicated as delegated design.

D. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.

E. Determine control valve sizes and flow coefficients by ISA 75.01.01.

F. Control valve characteristics and rangeability shall comply with ISA 75.11.01.

G. Selection Criteria:
   1. Control valves shall be suitable for operation at following conditions:
      a. Heating Hot Water: See schedule on drawings.
   2. Fail positions unless otherwise indicated:
      a. Heating Hot Water: Open.
   3. Minimum Cv shall be calculated at 10 percent of design flow, with a coincident pressure differential equal to the system design pump head.
   4. In water systems, select modulating control valves at terminal equipment for a design Cv based on a pressure drop of 5 psig (34 kPa) at design flow unless otherwise indicated.

2.2 BALL-STYLE CONTROL VALVES

A. Ball Valves with Single Port and Characterized Disk:
   1. Pressure Rating for NPS 1 ((DN 25)) and Smaller: Nominal 600 WOG.
   2. Pressure Rating for NPS 1-1/2 (DN 38) through NPS 2 (DN 50): Nominal 400 WOG.
   4. Process Temperature Range: Zero to 212 deg F (Minus 18 to plus 100 deg C).
   7. Ball: Chrome-plated brass or bronze or 300 series stainless steel.
   8. Stem and Stem Extension:
      a. Material to match ball.
b. Blowout-proof design.
c. Sleeve or other approved means to allow valve to be opened and closed without damaging the insulation or the vapor barrier seal.

9. Ball Seats: Reinforced PTFE.
10. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.

B. Ball Valves with Two Ports and Characterized Disk:

1. Pressure Rating for NPS 1 (DN 25) and Smaller: Nominal 600 WOG.
2. Pressure Rating for NPS 1-1/2 (DN 38) through NPS 2 (DN 50): Nominal 400 WOG.
4. Process Temperature Range: Zero to 212 deg F (Minus 18 to plus 100 deg C).
7. Ball: Chrome-plated brass or bronze or 300 series stainless steel.
8. Stem and Stem Extension:
   a. Material to match ball.
   b. Blowout-proof design.
   c. Sleeve or other approved means to allow valve to be opened and closed without damaging the insulation or the vapor barrier seal.
9. Ball Seats: Reinforced PTFE.
10. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.
12. Flow Characteristics for B-Port: Modified for constant common port flow.

C. Pressure-Independent Ball Valves NPS 2 (DN 50) and Smaller:

1. Performance:
   a. Pressure Rating: 600 psig (4137 kPa) for NPS 1 (DN 25) and 400 psig (2528 kPa) for NPS 1-1/2 and NPS 2 (DN 38 and DN 50).
   b. Close-off pressure of 200 psig (1379 kPa).
   c. Process Temperature Range: Between zero to 212 deg F (minus 18 to plus 100 deg C).
   d. Rangeability: 100 to 1.
2. Integral Pressure Regulator: Located upstream of ball to regulate pressure, to maintain a constant pressure differential while operating within a pressure differential range of 5 to 50 psig ((34 to 345 kPa)).
4. Ball: Chrome-plated brass.
5. Stem and Stem Extension: Chrome-plated brass, blowout-proof design.
6. Stem sleeve or other approved means to allow valve to be opened and closed without damaging field-applied insulation and insulation vapor barrier seal.
7. Ball Seats: Reinforced PTFE.
8. Stem Seal: Reinforced PTFE packing ring stem seal with threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if equivalent cycle endurance can be achieved.

2.3 BUTTERFLY-STYLE CONTROL VALVES

A. Commercial-Grade, Two-Way Butterfly Valves:

1. Performance:
   a. Bi-directional bubble tight shutoff at 250 psig (1724 kPa).
   b. Comply with MSS SP-67 or MSS SP-68.
   c. Rotation: Zero to 90 degrees.
   d. Linear or modified equal percentage flow characteristic.

2. Body: Cast iron ASTM A 126, Class B, ductile iron ASTM A 536 or cast steel ASTM A 216/A 216M WCB fully lugged, suitable for mating to ASME B16.5 flanges.
4. Shaft: 316 or 17-4 PH stainless steel.
5. Seat: Reinforced EPDM or reinforced PTFE with retaining ring.
7. Replaceable seat, disc, and shaft bushings.
8. Corrosion-resistant nameplate indicating:
   a. Manufacturer's name, model number, and serial number.
   b. Body size.
   c. Body and trim materials.
   d. Flow arrow.

B. Commercial-Grade, Three-Way Butterfly Valves:

1. Arrangement: Two valves mated to a fabricated tee with interconnecting mechanical linkage.
2. Performance:
   a. Bi-directional bubble tight shutoff at 250 psig (1724 kPa).
   b. Comply with MSS SP-67 or MSS SP-68.
   c. Rotation: Zero to 90 degrees.
   d. Linear or modified equal percentage flow characteristic.
3. Body: Cast iron ASTM A 126, Class B, ductile iron ASTM A 536 or cast steel ASTM A 216/A 216M WCB fully lugged, suitable for mating to ASME B16.5 flanges.
5. Shaft: 316 or 17-4 PH stainless steel.
6. Seat: Reinforced EPDM or reinforced PTFE seat with retaining ring.
7. Shaft Bushings: Reinforced PTFE or stainless steel.
8. Replaceable seat, disc, and shaft bushings.
9. Corrosion-resistant nameplate indicating:
   a. Manufacturer's name, model number, and serial number.
   b. Body size.
   c. Body and trim materials.
   d. Flow arrow.

2.4 GLOBE-STYLE CONTROL VALVES

A. General Globe-Style Valve Requirements:
   1. Globe-style control valve body dimensions shall comply with ISA 75.08.01.
   2. Construct the valves to be serviceable from the top.
   3. For cage guided valves, trim shall be field interchangeable for different valve flow characteristics, such as equal percentage, linear, and quick opening.
   4. Reduced trim for one nominal size smaller shall be available for industrial valves NPS 1 (DN 25) and larger.
   5. Replaceable seats and plugs.
   6. Furnish each control valve with a corrosion-resistant nameplate indicating the following:
      a. Manufacturer's name, model number, and serial number.
      b. Body and trim size.
      c. Arrow indicating direction of flow.

B. Two-Way Globe Valves NPS 2 (DN 50) and Smaller:
   2. Body: Cast bronze or forged brass with ASME B16.5, Class 250 rating.
   7. Plug, Seat, and Stem: Brass or stainless steel.
   8. Process Temperature Range: 35 to 248 deg F (2 to 120 deg C).
   9. Ambient Operating Temperature: 35 to 150 deg F (2 to 65 deg C).
   10. Leakage: FCI 70-2, Class IV.
   12. Equal percentage flow characteristic.

C. Three-Way Globe Valves NPS 2 (DN 50) and Smaller:
2. **Body:** Cast bronze or forged brass with ASME B16.5, Class 250 rating.
3. **End Connections:** Threaded.
4. **Bonnet:** Screwed.
5. **Packing:** PTFE V-ring.
6. **Plug:** Top guided.
7. **Plug, Seat, and Stem:** Brass or stainless steel.
8. **Process Temperature Range:** 35 to 248 deg F (2 to 120 deg C).
9. **Ambient Operating Temperature:** 35 to 150 deg F (2 to 65 deg C).
10. **Leakage:** FCI 70-2, Class IV.
11. **Rangeability:** 25 to 1.
12. **Linear flow characteristic.**

**D. Two-Way Globe Valves NPS 2-1/2 to NPS 6 (DN 65 to DN 150):**

1. **Globe Style:** Single port.
2. **Body:** Cast iron complying with ASME B61.1, Class 125.
3. **End Connections:** Flanged, suitable for mating to ASME B16.5, Class 150 flanges.
4. **Bonnet:** Bolted.
5. **Packing:** PTFE cone-ring.
6. **Plug:** Top or bottom guided.
7. **Plug, Seat, and Stem:** Brass or stainless steel.
8. **Process Temperature Rating:** 35 to 281 deg F (2 to 138 deg C).
9. **Leakage:** 0.1 percent of maximum flow.
10. **Rangeability:** Varies with valve size between 6 and 10 to 1.
11. **Modified linear flow characteristic.**

**E. Industrial-Grade Straight-Through Globe Valves NPS 1 (DN 25) and Larger:**

1. **Globe Style:** Single port.
2. **Body:** Cast iron or cast steel.
3. **End Connections for NPS 2 (DN 50):** Threaded.
4. **End Connections for NPS 2-1/2 (DN 65) and Larger:** Raised face flanged.
5. **Bonnet:** Bolted.
6. **Packing:** PTFE V-ring.
7. **Plug:** Cage guided and unbalanced.
8. **Plug, Seat, and Stem:** 416 stainless-steel plug and seat, 17-4 PH stainless-steel cage and 316 stainless-steel stem.
9. **Valve Stem:** Thread and pin stem to plug.
10. **Valve Stem Finish:** Polished to 5 microinches rms or less.
11. **Plug and Seat Surfaces:** Hardened facing.
12. **Process Temperature Range:** Zero to 450 deg F ((Minus 18 to plus 232 deg C)).
13. **Ambient Operating Temperature:** Minus 20 to plus 150 deg F (Minus 29 to plus 71 deg C).
14. **Leakage:** FCI 70-2, Class V.
15. **Flow Characteristic:** Quick opening.

### 2.5 SOLENOID VALVES

**A. Description:**
1. Action: Either normally open or normally closed in the event of electrical power failure as required by the application.
2. Size to close against the system pressure.
4. Heavy-duty assembly.
5. Body: Brass or stainless steel.
6. Seats and Discs: NBR or PTFE.

2.6 ELECTRIC AND ELECTRONIC CONTROL VALVE ACTUATORS

A. Actuators for Hydronic Control Valves: Capable of closing valve against system pump shutoff head.

B. Actuators for Steam Control Valves: Shutoff against 1.5 times steam design pressure.

C. Position indicator and graduated scale on each actuator.

D. Type: Motor operated, with or without gears, electric and electronic.

E. Voltage: Voltage selection delegated to professional designing control system.

F. Deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.

G. Function properly within a range of 85 to 120 percent of nameplate voltage.

H. Construction:
   1. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
   2. For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.
   3. For Actuators Larger Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

I. Field Adjustment:
   1. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.
   2. Gear Type Actuators: External manual adjustment mechanism to allow manual positioning when the actuator is not powered.

J. Two-Position Actuators: Single direction, spring return or reversing type.

K. Modulating Actuators:
1. Operation: Capable of stopping at all points across full range, and starting in either
direction from any point in range.
2. Control Input Signal:
   a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs.
      One input drives actuator to open position and other input drives actuator to close
      position. No signal of either input remains in last position.
   b. Proportional: Actuator drives proportional to input signal and modulates
      throughout its angle of rotation. Suitable for 4- to 20-mA signals.
   c. Pulse Width Modulation (PWM): Actuator drives to a specified position according
      to pulse duration (length) of signal from a dry contact closure, triac sink, or source
      controller.
   d. Programmable Multi-Function:
      1) Control Input, Position Feedback, and Running Time: Factory or field
         programmable.
      2) Diagnostic: Feedback of hunting or oscillation, mechanical overload,
         mechanical travel, and mechanical load limit.
      3) Service Data: Include, at a minimum, number of hours powered and number
         of hours in motion.

L. Position Feedback:
   1. Equip two-position actuators with limits switches or other positive means of a position
      indication signal for remote monitoring of open position.
   2. Equip modulating actuators with a position feedback through current or voltage signal for
      remote monitoring.
   3. Provide a position indicator and graduated scale on each actuator indicating open and
      closed travel limits.

M. Fail-Safe:
   1. Where indicated, provide actuator to fail to an end position.
   2. Internal spring return mechanism to drive controlled device to an end position (open or
      close) on loss of power.
   3. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are
      acceptable only where uniquely indicated.

N. Integral Overload Protection:
   1. Provide against overload throughout the entire operating range in both directions.
   2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or
      magnetic clutches are acceptable methods of protection.

O. Valve Attachment:
   1. Unless otherwise required for valve interface, provide an actuator designed to be directly
      coupled to valve shaft without the need for connecting linkages.
   2. Attach actuator to valve drive shaft in a way that ensures maximum transfer of power and
      torque without slippage.
3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

P. Temperature and Humidity:
   1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F.
   2. Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from 5 to 95 percent relative humidity, non-condensing.

Q. Enclosure:
   1. Suitable for ambient conditions encountered by application.
   2. NEMA 250, Type 2 for indoor and protected applications.
   3. NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.
   4. Provide actuator enclosure with heater and control where required by application.

R. Stroke Time:
   1. Operate valve from fully closed to fully open within 15 seconds.
   2. Operate valve from fully open to fully closed within 15 seconds.
   3. Move valve to failed position within 5 seconds.
   4. Select operating speed to be compatible with equipment and system operation.

S. Sound:
   1. Spring Return: 62 dBA.
   2. Non-Spring Return: 45 dBA.

PART 3 - EXECUTION

3.1 CONTROL VALVE APPLICATIONS

A. Control Valves:
   1. Select from valves specified in "Control Valves" Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.

3.2 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy most stringent requirements indicated.
B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Properly support instruments, tubing, piping, wiring, and conduits to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a 1.5 force.

D. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

E. Firestop penetrations made in fire-rated assemblies and seal penetrations made in acoustically rated assemblies.

F. Fastening Hardware:
   1. Stillson wrenches, pliers, and other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
   2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
   3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

G. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

H. Corrosive Environments:
   1. Use products that are suitable for environment to which they will be subjected.
   2. If possible, avoid or limit use of materials in corrosive environments, including, but not limited to, the following:
      a. Laboratory exhaust airstreams.
      b. Process exhaust airstreams.
   3. Use Type 316 stainless-steel tubing and fittings when in contact with a corrosive environment.
   4. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
   5. Where control devices are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.3 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.
B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 CONTROL VALVES

A. Install pipe reducers for valves smaller than line size. Position reducers as close to valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.

B. Install flanges or unions to allow drop-in and -out valve installation.

C. Where indicated, install control valve with three-valve bypass manifold to allow for control valve isolation and removal without interrupting system flow by providing manual throttling valve in bypass pipe.

D. Install drain valves in piping upstream and downstream of each control valve installed in a three-valve manifold and for each control valve larger than NPS 2 (DN 50).

E. Install pressure temperature taps in piping upstream and downstream of each control valve larger than NPS 2 (DN 50).

F. Valve Orientation:

1. Where possible, install globe and ball valves installed in horizontal piping with stems upright and not more than 15 degrees off of vertical, not inverted.
2. Install valves in a position to allow full stem movement.
3. Where possible, install butterfly valves that are installed in horizontal piping with stems in horizontal position and with low point of disc opening with direction of flow.

G. Clearance:

1. Locate valves for easy access and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.
2. Install valves with at least 12 inches (300 mm) of clear space around valve and between valves and adjacent surfaces.

H. Threaded Valves:

1. Note internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
2. Align threads at point of assembly.
3. Apply thread compound to external pipe threads, except where dry seal threading is specified.
4. Assemble joint, wrench tight. Apply wrench on valve end as pipe is being threaded.

I. Flanged Valves:
   1. Align flange surfaces parallel.
   2. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

J. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

K. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

L. Install engraved phenolic nameplate with valve identification on valve and on face of ceiling directly below valves concealed above ceilings.

3.5 CHECKOUT PROCEDURES

A. Control Valve Checkout:
   1. Check installed products before continuity tests, leak tests, and calibration.
   2. Check valves for proper location and accessibility.
   3. Check valves for proper installation for direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
   4. For pneumatic products, verify air supply for each product is properly installed.
   5. For pneumatic valves, verify that pressure gauges are provided in each air line to valve actuator and positioner.
   6. Verify that control valves are installed correctly for flow direction.
   7. Verify that valve body attachment is properly secured and sealed.
   8. Verify that valve actuator and linkage attachment are secure.
   9. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
  10. Verify that valve ball, disc, and plug travel are unobstructed.
  11. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

3.6 ADJUSTMENT, CALIBRATION, AND TESTING

A. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.
C. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

D. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION 23 09 23.11
PART 1 - GENERAL

1.1 SUMMARY

A. Section includes control dampers and actuators for DDC systems.

B. Related Requirements:
   1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
   2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.12.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal:
   1. Schedule and design calculations for control dampers and actuators, including the following.
      a. Flow at project design and minimum flow conditions.
      b. Face velocity at project design and minimum airflow conditions.
      c. Pressure drop across damper at project design and minimum airflow conditions.
      d. AMCA 500D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
      e. Maximum close-off pressure.
      f. Leakage airflow at maximum system pressure differential (fan close-off pressure).
      g. Torque required at worst case condition for sizing actuator.
      h. Actuator selection indicating torque provided.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to size products where indicated as delegated design.

D. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.

E. Selection Criteria:
   1. Control dampers shall be suitable for operation at following conditions:
      a. See schedule on drawings.
   2. Fail positions unless otherwise indicated:
      a. Supply Air: Open.
      b. Return Air: Open.
      c. Outdoor Air: Close.
      d. Mixed Air: Open.
      e. Exhaust Air: Open.
   3. Select modulating dampers for a pressure drop of 2 percent of fan total static pressure unless otherwise indicated.

2.2 RECTANGULAR CONTROL DAMPERS

A. General Requirements:
   1. Unless otherwise indicated, use parallel blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed blade configuration.
   2. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.

B. Rectangular Dampers with Aluminum Airfoil Blades:
   1. Performance:
      a. Leakage: AMCA 511, Class 1A. Leakage shall not exceed 3 cfm/sq. ft. (15.2 L/s per sq. m) against 1-in. wg (250-Pa) differential static pressure.
b. Pressure Drop: 0.05-in. wg (12.5 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested according to AMCA 500-D, figure 5.3.

c. Velocity: Up to 6000 fpm (30 m/s).

d. Temperature: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

f. Damper shall have AMCA seal for both air leakage and air performance.

2. Construction:

a. Frame:

1) Material: ASTM B 211, Alloy 6063 T5 extruded-aluminum profiles, 0.07 inch (1.8 mm) thick.
2) Hat-shaped channel with integral flange(s). Mating face shall be a minimum of 1 inch (25 mm).
3) Width not less than 5 inches (125 mm).

b. Blades:

1) Hollow, airfoil, extruded aluminum.
2) Parallel or opposed blade configuration as required by application.
3) Material: ASTM B 211, Alloy 6063 T5 aluminum, 0.07 inch (1.8 mm) thick.
4) Width not to exceed 6 inches (150 mm).
5) Length as required by close-off pressure, not to exceed 48 inches (1200 mm).

c. Seals:

1) Blades: Replaceable, mechanically attached extruded silicone, vinyl, or plastic composite.
2) Jambs: Stainless steel, compression type.

d. Axles: 0.5-inch- (13-mm-) diameter plated or stainless steel, mechanically attached to blades.

e. Bearings:

1) Molded synthetic or stainless-steel sleeve mounted in frame.
2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

1) Concealed in frame.
2) Constructed of aluminum and plated or stainless steel.
3) Hardware: Stainless steel.

g. Transition:

1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connection.
2) Factory mount damper in a sleeve with a close transition to mate to field connection.
3) Damper size and sleeve shall be connection size plus 2 inches (50 mm).
4) Sleeve length shall be not less than 12 inches (300 mm) for dampers without jackshafts and shall be not less than 16 inches (450 mm) for dampers with jackshafts.
5) Sleeve material shall match adjacent duct.

h. Additional Corrosion Protection for Corrosive Environments:
   1) Provide anodized finish for aluminum surfaces in contact with airstream. Anodized finish shall be a minimum of 0.0007 inch (0.018 mm) thick.
   2) Axles, damper linkage, and hardware shall be constructed of Type 316L stainless steel.

3. Airflow Measurement:
   a. Where indicated, provide damper assembly with integral airflow monitoring.
   b. Zero- to 10-V dc or 4- to 20-mA scaled output signal for remote monitoring of actual airflow.
   c. Accuracy shall be within 5 percent of the actual flow rate between the range of minimum and design airflow. For applications with a large variation in range between the minimum and design airflow, configure the damper sections and flow measurement assembly as required to comply with the stated accuracy over the entire modulating range.
   d. Provide a straightening device as part of the flow measurement assembly to achieve the specified accuracy with configuration indicated.
   e. Suitable for operation in untreated and unfiltered air.
   f. Provide temperature and altitude compensation and correction to maintain accuracy over temperature range encountered at site altitude.
   g. Provide automatic zeroing feature.

4. Airflow Control:
   a. Where indicated, provide damper assembly with integral airflow measurement and control.
   b. A factory-furnished and -calibrated controller shall be programmed, in nonvolatile EPROM, with application-specific airflow set point and range.
   c. The controller and actuator shall communicate to control the desired airflow.
   d. The controller shall receive a zero- to 10-V dc input signal and report a zero- to 20-mA output signal that is proportional to the airflow.
   e. Airflow measurement and control range shall be suitable for operation between 150 to 2000 fpm (0.8 to 10 m/s).
   f. Ambient Operating Temperature Range: Minus 40 to plus 140 deg F (Minus 40 to plus 60 deg C).
   g. Ambient Operating Humidity Range: 5 to 95 percent relative humidity, non-condensing.
   h. Provide unit with control transformer rated for not less than 85 VA. Provide transformer with primary and secondary protection and primary disconnecting means. Coordinate requirements with field power connection.
i. Provide screw terminals for interface to field wiring.

j. Factory mount electronics within a NEMA 250, Type 1 painted steel enclosure.

C. Rectangular Dampers with Steel Airfoil Blades:

1. Performance:

   a. Leakage: AMCA 511, Class IA. Leakage shall not exceed 3 cfm/sq. ft. (15.2 L/s per sq. m) against 1-in. wg (250-Pa) differential static pressure.

   b. Pressure Drop: 0.06-in. wg (15 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested according to AMCA 500-D, figure 5.3.

   c. Velocity: Up to 6000 fpm (30 m/s).

   d. Temperature: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

   e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

   f. Damper shall have AMCA seal for both air leakage and air performance.

2. Construction:

   a. Frame:

      1) Material: ASTM A 653/A 653M galvanized-steel profiles, 0.06 inch (1.6 mm) thick.

      2) Hat-shaped channel with integral flanges. Mating face shall be a minimum of 1 inch (25 mm).

      3) Width not less than 5 inches (125 mm).

   b. Blades:

      1) Hollow, airfoil, galvanized steel.

      2) Parallel or opposed blade configuration as required by application.

      3) Material: ASTM A 653/A 653M galvanized steel, 0.05 inch (1.3 mm) thick.

      4) Width not to exceed 6 inches (150 mm).

      5) Length as required by close-off pressure, not to exceed 48 inches (1200 mm).

   c. Seals:

      1) Blades: Replaceable, mechanically attached extruded silicone, vinyl, or plastic composite.

      2) Jambs: Stainless steel, compression type.

   d. Axles: 0.5-inch- (13-mm-) diameter plated or stainless steel, mechanically attached to blades.

   e. Bearings:

      1) Stainless steel mounted in frame.

      2) Where blade axles are installed in vertical position, provide thrust bearings.

   f. Linkage:
1) Concealed in frame.
2) Constructed of aluminum and plated or stainless steel.
3) Hardware: Stainless steel.

g. Transition:
1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connection.
2) Factory mount damper in a sleeve with a close transition to mate to field connection.
3) Damper size and sleeve shall be connection size plus 2 inches (50 mm).
4) Sleeve length shall be not less than 12 inches (300 mm) for dampers without jackshafts and shall be not less than 16 inches (450 mm) for dampers with jackshafts.
5) Sleeve material shall match adjacent duct.

h. Additional Corrosion Protection for Corrosive Environments:
1) Provide epoxy finish for surfaces in contact with airstream.
2) Axles, damper linkage, and hardware shall be constructed of Type 316L stainless steel.

D. Rectangular Dampers with Aluminum Flat Blades:

1. Performance:
   a. Leakage: Leakage shall not exceed 3.2 cfm/sq. ft. (16.2 L/s per sq. m) against 1-in. wg (250-Pa) differential static pressure.
   b. Pressure Drop: 0.07-in. wg (17.5 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested according to AMCA 500-D, figure 5.3.
   c. Velocity: Up to 2000 fpm (10 m/s).
   d. Temperature: Minus 50 to plus 250 deg F (Minus 46 to plus 121 deg C).
   e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length, not to exceed 3-in. wg (750 Pa).
   f. Damper shall have AMCA seal for both air leakage and air performance.

2. Construction:
   a. Frame:
      1) Material: ASTM B 211, Alloy 6063 T5 extruded-aluminum profiles, 0.12 inch (3.2 mm) thick.
      2) Hat-shaped channel with integral flanges.
      3) Width not less than 5 inches (125 mm).
   b. Blades:
      1) Flat blades of extruded aluminum.
      2) Parallel or opposed blade configuration as required by application.
3) Material: ASTM B 211, Alloy 6063 T5 extruded-aluminum profiles, 0.12 inch (3.2 mm) thick.
4) Width not to exceed 6 inches (150 mm).
5) Length as required by close-off pressure, not to exceed 48 inches (1200 mm).

c. Seals:
   1) Blades: Replaceable, mechanically attached extruded silicone, vinyl or plastic composite.
   2) Jambs: Stainless steel, compression type.

d. Axles: 0.5-inch- ((13-mm-))diameter plated or stainless steel, mechanically attached to blades.

e. Bearings:
   1) Molded-synthetic sleeve, mounted in frame.
   2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:
   1) Concealed in frame.
   2) Constructed of plated or stainless steel.
   3) Hardware: Stainless steel.

g. Transition:
   1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connection.
   2) Factory mount damper in a sleeve with a close transition to mate to field connection.
   3) Damper size and sleeve shall be connection size plus 2 inches (50 mm).
   4) Sleeve length shall be not less than 12 inches (300 mm) for dampers without jackshafts and shall be not less than 16 inches (450 mm) for dampers with jackshafts.
   5) Sleeve material shall match adjacent duct.

h. Additional Corrosion Protection for Corrosive Environments:
   1) Provide anodized finish for aluminum surfaces in contact with airstream. Anodized finish shall be a minimum of 0.0007 inch (0.018 mm) thick.
   2) Axles, damper linkage, and hardware shall be constructed of Type 316L stainless steel.

E. Rectangular Dampers with Steel Flat Blades:
   1. Performance:
      a. Leakage: Leakage shall not exceed 4.8 cfm/sq. ft. (24.3 L/s per sq. m) against 1-in. wg (250-Pa) differential static pressure.
b. Pressure Drop: 0.1-in. wg (25 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested according to AMCA 500-D, figure 5.3.

c. Velocity: Up to 1500 fpm (7.6 m/s).

d. Temperature: Minus 25 to plus 180 deg F (Minus 32 to plus 82 deg C).

e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length, not to exceed 4-in. wg (1000 Pa).

f. Damper shall have AMCA seal for both air leakage and air performance.

2. Construction:

a. Frame:

1) Material: Stainless steel, 0.06 inch (1.6 mm) thick.
2) Hat-shaped channel with integral flanges.
3) Width not less than 5 inches (125 mm).

b. Blades:

1) Flat blades with multiple grooves positioned axially for reinforcement.
2) Parallel or opposed blade configuration as required by application.
3) Material: Galvanized or stainless steel, 0.06 inch (1.6 mm) thick.
4) Width not to exceed 6 inches (150 mm).
5) Length as required by close-off pressure, not to exceed 48 inches (1200 mm).

c. Seals:

1) Blades: Replaceable, mechanically attached, PVC-coated polyester.
2) Jambs: Stainless steel, compression type.

d. Axles: 0.5-inch- (13-mm-) diameter plated or stainless steel, mechanically attached to blades.

e. Bearings:

1) Molded-synthetic sleeve, mounted in frame.
2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

1) Concealed in frame.
2) Constructed of plated or stainless steel.
3) Hardware: Stainless steel.

2.3 GENERAL CONTROL-DAMPER ACTUATORS REQUIREMENTS

A. Actuators shall operate related damper(s) with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which the damper is subjected.
B. Actuators shall produce sufficient power and torque to close off against the maximum system pressures encountered. Actuators shall be sized to close off against the fan shutoff pressure as a minimum requirement.

C. The total damper area operated by an actuator shall not exceed 80 percent of manufacturer's maximum area rating.

D. Provide one actuator for each damper assembly where possible. Multiple actuators required to drive a single damper assembly shall operate in unison.

E. Avoid the use of excessively oversized actuators which could overdrive and cause linkage failure when the damper blade has reached either its full open or closed position.

F. Use jackshafts and shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.

G. Provide mounting hardware and linkages for connecting actuator to damper.

H. Select actuators to fail in desired position in the event of a power failure.

I. Actuator Fail Positions: As indicated below:
   1. Exhaust Air: Open.
   2. Outdoor Air: Close.
   4. Return Air: Open.

2.4 ELECTRIC AND ELECTRONIC ACTUATORS

A. Type: Motor operated, with or without gears, electric and electronic.

B. Voltage:
   1. See Drawings.
   2. Actuator shall deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
   3. Actuator shall function properly within a range of 85 to 120 percent of nameplate voltage.

C. Construction:
   1. Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
   2. 100 up to 400 W: Gears ground steel, oil immersed, shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.
D. Field Adjustment:
   1. Spring return actuators shall be easily switchable from fail open to fail closed in the field without replacement.
   2. Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when the actuator is not powered.

E. Two-Position Actuators: Single direction, spring return or reversing type.

F. Modulating Actuators:
   1. Capable of stopping at all points across full range, and starting in either direction from any point in range.
   2. Control Input Signal:
      a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position, and other input drives actuator to close position. No signal of either input remains in last position.
      b. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for 4- to 20-mA signals.
      c. Pulse Width Modulation (PWM): Actuator drives to a specified position according to a pulse duration (length) of signal from a dry-contact closure, triac sink or source controller.
      d. Programmable Multi-Function:
         1) Control input, position feedback, and running time shall be factory or field programmable.
         2) Diagnostic feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
         3) Service data, including at a minimum, number of hours powered and number of hours in motion.

G. Position Feedback:
   1. Equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.
   2. Equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.
   3. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

H. Fail-Safe:
   1. Where indicated, provide actuator to fail to an end position.
   2. Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
   3. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

I. Integral Overload Protection:
1. Provide against overload throughout the entire operating range in both directions.
2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

J. Damper Attachment:
1. Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.
2. Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.
3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

K. Temperature and Humidity:
1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F (minus 29 to plus 49 deg C).
2. Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from 5 to 95 percent relative humidity, non-condensing.

L. Enclosure:
1. Suitable for ambient conditions encountered by application.
2. NEMA 250, Type 2 for indoor and protected applications.
3. NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.
4. Provide actuator enclosure with a heater and controller where required by application.

M. Stroke Time:
1. Operate damper from fully closed to fully open within 15 seconds.
2. Operate damper from fully open to fully closed within 15 seconds.
3. Move damper to failed position within 5 seconds.
4. Select operating speed to be compatible with equipment and system operation.
5. Actuators operating in smoke control systems comply with governing code and NFPA requirements.

N. Sound:
1. Spring Return: 62 dBA.
2. Non-Spring Return: 45 dBA.

PART 3 - EXECUTION

3.1 CONTROL-DAMPER APPLICATIONS

A. Control Dampers:
B. Select from damper types indicated in "Control Dampers" Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.

1. Rectangular Exhaust Air Duct Applications with SMACNA Construction Class: Rectangular dampers with aluminum airfoil blades.
2. Round Exhaust Air Duct Applications with SMACNA Construction Class: Rectangular dampers with aluminum airfoil blades.
3. Rectangular Outdoor Air Duct Applications with SMACNA Construction Class: Rectangular dampers with aluminum airfoil blades.
4. Round Outdoor Air Duct Applications with SMACNA Construction Class: Rectangular dampers with aluminum airfoil blades.
5. Rectangular Return Air Duct Applications with SMACNA Construction Class: Rectangular dampers with aluminum airfoil blades.
6. Round Return Air Duct Applications with SMACNA Construction Class: Rectangular dampers with aluminum airfoil blades.
7. Rectangular Supply Air Duct Applications with SMACNA Construction Class: Rectangular dampers with aluminum airfoil blades.
8. Round Supply Air Duct Applications with SMACNA Construction Class: Rectangular dampers with aluminum airfoil blades.

3.2 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy most stringent requirements indicated.

B. Properly support dampers and actuators, tubing, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a 1.5 force.

C. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

D. Seal penetrations made in fire-rated and acoustically rated assemblies.

E. Fastening Hardware:

1. Stillson wrenches, pliers, or other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

F. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
3.3 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 CONTROL DAMPERS

A. Install smooth transitions, not exceeding 15 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.

B. Clearance:
   1. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
   2. Install dampers with at least 24 inches (600 mm) of clear space on sides of dampers requiring service access.

C. Service Access:
   1. Dampers and actuators shall be accessible for visual inspection and service.
   2. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Section 233300 "Air Duct Accessories."

D. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.

E. Attach actuator(s) to damper drive shaft.

F. For duct-mounted and equipment-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.

G. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

H. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."Section 16075 "Electrical Identification."
I. Install engraved phenolic nameplate with damper identification on damper and on face of ceiling where damper is concealed above ceiling.

3.5 CHECKOUT PROCEDURES

A. Control-Damper Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.
2. Check dampers for proper location and accessibility.
3. Verify that control dampers are installed correctly for flow direction.
4. Verify that proper blade alignment, either parallel or opposed, has been provided.
5. Verify that damper frame attachment is properly secured and sealed.
6. Verify that damper actuator and linkage attachment are secure.
7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
8. Verify that damper blade travel is unobstructed.

3.6 ADJUSTMENT, CALIBRATION, AND TESTING:

A. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

C. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION 23 09 23.12
SECTION 23.09 23.14 - FLOW INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Airflow sensors.
   2. Airflow switches.
   3. Airflow transmitters.
   4. Liquid flow meters.
   5. Liquid flow sensors.
   7. Liquid flow transmitters.

B. Related Requirements:
   1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.


C. Shop Drawings:
   1. Include plans, elevations, sections, and mounting details.
   2. Include diagrams for power, signal, and control wiring.
   3. Include diagrams for air and process signal tubing.
   4. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

D. Delegated-Design Submittal:
   1. Schedule and design calculations for flow instruments, including the following.
      a. Flow at Project design and minimum flow conditions.
      b. Pressure drop at Project design and minimum flow conditions.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each product requiring a certificate.
1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Select and size products to achieve specified performance requirements.

B. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 GENERAL REQUIREMENTS FOR FLOW INSTRUMENTS

A. Air sensors and transmitters shall have an extended range of 20 percent above Project design flow and 20 percent below minimum Project flow to signal abnormal flow conditions and to provide flexibility for changes in operation.

B. Liquid and steam sensors, meters, and transmitters shall have an extended range of 20 percent above Project design flow and 20 percent below Project minimum flow to signal abnormal flow conditions and to provide flexibility for changes in operation.

2.3 AIRFLOW SENSORS:

A. Performance Requirements:

1. Adjustable for changes in system operational parameters.

2. Airflow Sensor and Transmitter Range: Extended range of 20 percent above Project design flow and 20 percent below minimum Project flow to signal abnormal flow conditions.

3. Manufacturer shall certify that each flow instrument indicated complies with specified performance requirements and characteristics.

   a. Product certificates are required.

B. Pitot-Tube Airflow Sensor Station:

1. Description: Multiple total- and static-pressure sensors positioned at the center of equal area of the station cross section and interconnected by respective averaging manifolds.

   a. Stations 4 sq. ft. (0.4 sq. m) and Smaller: One total-pressure sensor and one static-pressure sensor for every 16 sq. in. (103 sq. cm) of station area.

   b. Stations Larger than 4 sq. ft. (0.4 sq. m): One total-pressure sensor and one static-pressure sensor for every 36 sq. in. (232 sq. cm) of station area.
2. Casing: Galvanized sheet steel at least 0.079 inch (2.0 mm) thick with coating complying with ASTM A 653/A 653M, G90 (Z275). Casings shall be stainless steel, 0.0781 inch (2.0 mm) thick, when connected to stainless duct and aluminum, 0.063 inch (1.6 mm) thick, when connected to aluminum duct.
   a. Joints and Seams: Continuously weld. Clean galvanized areas damaged by welding and coat with aluminum paint.
   b. Casing Depth: At least 8 inches (200 mm).
   c. Casing Flanges: Outward flange, minimum flange face 1.5 inches (38 mm).
   d. Casing Configuration and Size: Match shape (rectangular, round, flat oval) and same size as adjacent duct unless otherwise indicated.

3. Include an open parallel cell air straightener or air equalizer honeycomb mechanically fastened to casing.
   a. Construct straightener or equalizer from Type 3003 aluminum or Type 316 stainless steel, depending on casing material. Use stainless steel for units with stainless-steel casings.

4. Construct pressure sensor array from drawn copper or stainless-steel tubing. Use stainless steel for units with stainless-steel casings. Copper tubing shall comply with ASTM B 75 and ASTM B 280. Minimum tube wall thickness shall be 0.030 inch (0.8 mm). Include internal piping and external pressure transmitter ports.

5. Station Labeling: Identification label on each station casing indicating model number, size, area, and application-specific airflow range.

6. Performance:
   a. Pressure Loss: 0.015-inch wg (3.8 Pa) at 1000 fpm (5 m/s), or 0.085-inch wg (22.5 Pa) at 2000 fpm (10 m/s).
   b. Accuracy: Within 2 percent of actual airflow.
   c. Self-Generated Sound: NC 40 and sound level within the duct shall not be amplified.
   d. Performance rated and tested according to AMCA 610. Each station shall bear the AMCA seal.

C. Thermal Airflow Station:

1. Source Limitations: Obtain airflow and temperature measuring sensors and transmitters from single manufacturer.

2. Description: Airflow station shall consist of one or more sensor probes mounted in a casing, and a remotely mounted microprocessor-based transmitter.

3. Performance:
   a. Capable of independently processing up to 16 independently wired sensor assemblies.
   b. Airflow rate of each sensor assembly shall be equally weighted and averaged by transmitter prior to output.
   c. Temperature of each sensor assembly shall be velocity weighted and averaged by transmitter prior to output.
d. Listed and labeled by an NRTL as successfully tested as an assembly according to UL 873, "Temperature-Indicating and Regulating Equipment."

e. Components shall be interconnected by exposed NRTL-listed plenum-rated cable or non-listed cable placed in conduit.

f. Each flow station shall be factory calibrated at a minimum of 16 airflow rates and three temperatures to standards that are traceable to NIST.

g. Airflow Accuracy: Within 2 percent of reading over the entire operating airflow range.

1) Devices whose accuracy is combined accuracy of transmitter and sensor probes must demonstrate that total accuracy meets the performance requirements throughout the measurement range.

h. Temperature Accuracy: Within 0.2 deg F (0.11 deg C) over entire operating range of minus 20 to plus 140 deg F (minus 29 to plus 60 deg C).

i. Sensor Ambient Operating Temperature Range: Minus 20 to plus 160 deg F (minus 29 to plus 71 deg C).

j. Transmitter Ambient Operating Temperature Range: Minus 20 to plus 120 deg F (minus 29 to plus 49 deg C).

k. Sensor and Transmitter Ambient Operating Humidity Range: Zero to 99 percent, non-condensing.

l. Instrument shall compensate for changes in air temperature and density throughout calibrated velocity range for seasonal extremes at Project location.

m. Pressure Drop: 0.05-inch wg (12.5 Pa) at 2000 fpm (10.2 m/s) across a 24-by-24-inch (600-by-600-mm) area.

n. Instruments mounted in throat or face of fan inlet cone shall not negatively influence fan performance by reducing flow more than 2 percent of Project design flow or negatively impact fan-generated sound. Losses in performance shall be documented with submittal data, and adjustments to compensate for performance impact shall be made to fan in order to deliver Project design airflow indicated.

4. Sensor Assemblies:

a. Each sensor probe shall contain two individually wired, hermetically sealed bead-in-glass thermistors.

b. Mount thermistors in sensor using a marine-grade, waterproof epoxy.

c. Thermistor leads shall be protected and not exposed to the environment.

d. Each sensor assembly shall independently determine airflow rate and temperature at each measurement point.

e. Each sensor probe shall have an integral cable for connection to remotely mounted transmitter.

f. Sensor Probe Material: Gold anodized, extruded 6063 aluminum tube or Type 304 stainless steel.

g. Probe Assembly Mounting Brackets Material: Type 304 stainless steel.

5. Casing:

a. Factory mount sensor probes in an airflow station casing to create a single assembly for field mounting.
b. Material: Galvanized sheet steel at least 0.079 inch (2.0 mm) thick with coating complying with ASTM A 653/A 653M, G90 (Z275). Casings shall be stainless steel, 0.0781 inch (2.0 mm) thick, when connected to stainless duct and aluminum, 0.063 inch (1.6 mm) thick, when connected to aluminum duct.

c. Joints and Seams: Continuously weld. Clean galvanized areas damaged by welding and coat with zinc-rich paint.

d. Casing Depth: At least 8 inches (200 mm).

e. Include casing inlet and discharge connections with a minimum 2-inch (50-mm) face flange.
6. Transmitter:
   a. Integral digital display capable of simultaneously displaying total airflow and average temperature, individual airflow, and temperature readings of each independent sensor assembly.
   b. Capable of field configuration and diagnostics using an onboard push-button interface and digital display.

   1) Include an integral power switch to operate on 24-V ac (isolation not required) and include the following:
      a) Integral protection from transients and power surges.
      b) Circuitry to ensure reset after power disruption, transients, and brownouts.
      c) Integral transformer to convert field power source to operating voltage required by instrument.

   c. Remote Signal Interface:
      1) Linear Analog Signals for Airflow and Temperature: Fuse protected and isolated, zero- to 10-V dc or 4 to 20 mA.
      2) RS-485: BACnet-ARCNET, BACnet-MS/TP, and Modbus-RTU.
      3) 10 Base-T Ethernet: BACnet Ethernet, BACnet-IP, Modbus-TCP, and TCP/IP.
      4) LonWorks free topology.

2.4 AIRFLOW SWITCHES

A. Polymer Film Sail Switch:

   1. Performance:
      a. Suitable for applications operating at velocities up to 400 fpm (2.0 m/s).
      b. Suitable for mounting with air direction in horizontal, vertical up or down.
      c. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
      d. Voltage: 24-, 120-, 240-V ac.
      e. Normally Open Full Load Current: 2 A at 120-V ac.
      f. Normally Closed Full Load Current: 1 A at 120-V ac.
      g. Normally open switch actuates at 250 fpm (1.3 m/s) and opens at 75 fpm (0.4 m/s).
      h. Normally closed switch actuates at 75 fpm (0.4 m/s) and closes at 250 fpm (1.3 m/s).
      i. Maximum Process Temperature: 170 deg F (77 deg C).
      j. Maximum Ambient Temperature: 125 deg F (52 deg C).

   2. Construction:
      a. Polyester film sail encasing a wire frame.
b. Sail actuates a SPDT snap switch.
d. Enclosure with removable cover.
e. NEMA 250, Type 1 enclosure.
f. Removable spring counterbalances sail to allow mounting in either vertical (up or down) or horizontal airflow.
g. Electrical Connections: Screw terminals.
h. Conduit Connections: 1/2-inch (16-mm) trade size conduit knock outs on top and bottom.

B. Stainless-Steel Single Vane Switch:

1. Description:
   a. Velocities up to 2000 fpm (10.2 m/s).
   b. Suitable for mounting with air direction in horizontal.

2. Performance:
   a. Voltage: 125-, 240-, and 480-V ac.
   b. Full Load Current: 9.8 A at 125-V ac.
   c. Field-Adjustable Velocity Set Point: 400 to 1600 fpm (2.0 to 8.2 m/s).
   d. Maximum Process Temperature: 180 deg F (82 deg C).
   e. Maximum Ambient Temperature: 125 deg F (52 deg C).

3. Construction:
   a. Stainless-steel vane.
   b. Vane actuates a SPDT snap switch.
   d. Enclosure with removable cover.
   e. NEMA 250, Type 1 enclosure.
   f. Screw set-point adjustment.
   g. Electrical Connections: Screw terminals.
   h. Conduit Connections: 1-inch (27-mm) trade size conduit knock outs on top and bottom.

2.5 AIRFLOW TRANSMITTERS

A. Airflow Transmitters with 0.25 Percent Accuracy and Auto-Zero Feature:

1. Transmitter shall receive total- and static-pressure signals from a flow element, amplify signals, extract the square foot, and scale the signals to produce 4- to 20-mA dc output signals linear to airflow.
2. NEMA 250, Type 1 enclosure.
3. Construct assembly so shock, vibration, and pressures surges of up to 1 psig (6.9 kPa) will neither harm transmitter, nor affect its accuracy.
4. Transmitter with automatic zeroing circuit capable of automatically readjusting transmitter zero at predetermined time intervals. The automatic zeroing circuit shall re-zero the transmitter to within 0.1 percent of true zero.

5. Performance:

   a. Range: As required by application and at least 10 percent below minimum airflow and 10 percent greater than design airflow.
   b. Calibrated Span: Field adjustable, minus 40 percent of the range.
   c. Accuracy: Within 0.25 percent of natural span.
   d. Repeatability: Within 0.15 percent of calibrated span.
   e. Linearity: Within 0.2 percent of calibrated span.
   f. Hysteresis and Deadband (Combined): Less than 0.2 percent of calibrated span.

6. Integral digital display for continuous indication of airflow.

B. Pressure Differential Transmitters for Airflow Measurement:

1. Performance:

   a. Range: As required by application and at least 10 percent below minimum airflow and 10 percent greater than design airflow.
   b. Accuracy: Within 0.5 percent of the full-scale range.
   c. Hysteresis: Within 0.10 percent of full scale.
   d. Repeatability: Within 0.05 percent of full scale.
   e. Stability: Within one percent of span per year.
   f. Overpressure: 10 psig (69 kPa).
   g. Temperature Limits: Zero to 150 deg F (Minus 18 to plus 66 deg C).
   h. Compensate Temperature Limits: 40 to 150 deg F (4 to 66 deg C).
   i. Thermal Effects: 0.033 percent of full scale per degree F.
   j. Shock and vibration shall not harm the transmitter.

2. Output Signals:

   a. Analog Current Signal:
      1) Two-wire, 4- to 20-mA dc current source.
      2) Signal capable of operating into 800-ohm load.

   b. Analog Voltage Signal:
      1) Three wire, zero to 10 V.
      2) Minimum Load Resistance: 1000 ohms.

3. Display: Four-digit digital with minimum 0.4-inch- (10-mm-) high numeric characters.

4. Operator Interface:

   a. Zero and span adjustments located behind cover.

5. Construction:
a. Plastic casing with removable plastic cover.
b. Fittings: Swivel fittings for connection to copper tubing or barbed fittings for connection to polyethylene tubing. Fittings on bottom of instrument case.
c. Screw terminal block for wire connections.
d. Vertical plane mounting.
e. NEMA 250, Type 4.
f. Mounting Bracket: Appropriate for installation.

2.6 LIQUID FLOW METERS

A. General Requirements for Liquid Flow Meters:
   1. Adjustable for changes in system operational parameters.
   2. Liquid and Steam Sensors, Meters, and Transmitters: Extended range of 20 percent above Project design flow and 20 percent below Project minimum flow to signal abnormal flow conditions.
   3. Manufacturer shall certify that each flow instrument indicated complies with specified performance requirements and characteristics.
   4. Product certificates are required.

B. Insertion Paddle Wheel Flow Meter, NPS 1 (DN 25):
   1. Description:
      a. Insertion-type meter with a non-magnetic spinning paddle wheel.
      b. Each meter shall be wet calibrated at factory to standards traceable to NIST and provided with a certificate of calibration.
      c. Programming kit including cable connector and Microsoft-Windows-compatible software.
      d. Where indicated, provide meter with bi-directional flow measurement.
   2. Performance:
      a. Range: 0.33 to 20 fps (0.1 to 6.1 m/s).
      b. Accuracy: Within 1 percent of flow rate.
      c. Repeatability: Within 0.5 percent.
      d. Ambient Temperature: 14 to 150 deg F (Minus 10 to plus 66 deg C).
      e. Maximum Process Temperature: 300 deg F (149 deg C) with PEEK sensor tip.
      f. Maximum Pressure: 350 psig at 300 deg F (2413 kPa at 149 deg C) with PEEK sensor tip.
      g. Pressure Drop: Up to 0.5 psig at 10 fps (3.5 kPa at 3 m/s) for pipe sizes NPS 1-1/2 (DN 20) and larger.
   3. Output Signal:
      b. Unidirectional Flow Meter: Analog, two wire, loop-powered, 4- to 20-mA signal.
      d. Bi-directional Flow Meter: Analog 4- to 20-mA signal plus direction.
e. Bi-directional Flow Meter: Scaled pulse.

4. Operator Interface:
   a. Programming: Instrument programming through computer and programming kit.
   b. Digital Display: Eight-character digital display of flow rate, flow totalization, input, output, and flow direction for bi-directional meters.

5. Construction:
   a. Wetted Metal Parts (Including Sensor Stem, Mounting Adapter, and Isolation Valve): Type 316 stainless steel.
   b. Sensor Tip: PPS or PEEK.
   c. Shaft: Tungsten carbide.
   d. Impeller: Stainless steel.
   f. Instrument Isolation Valve: Full port ball valve for system isolation.
   g. Insertion Depth: Threaded positioning nut for accurate sensor depth in the pipe.
   h. Electronics Enclosure:
      1) Polypropylene with Viton-sealed acrylic cover.
      2) Removable cover.
      3) NEMA 250, Type 4X.
      4) Electrical Connection: Screw terminals.
      5) Conduit Connection: 1/2-inch (16-mm) trade size.

C. Insertion Turbine Flow Meter:

1. Description:
   a. Operating pressure of 300 psig (2068 kPa) with a temperature of 200 deg F (93 deg C).
   b. Meters in hot water systems shall be suitable for maximum system temperatures encountered, but not less than 250 deg F (121 deg C).
   c. Pressure drop not to exceed 1 psig (6.9 kPa) at 20-fps (6.1-m/s) flow velocity in a NPS 2 (DN 50) pipe and decreasing in large pipe with lower velocity.
   d. Sensor Accuracy:
      1) Within 1 percent of actual flow between the flow velocity range of 3 to 30 fps (0.9 to 9.1 m/s).
      2) Within 2 percent of actual flow between the flow velocity range of 0.4 to 20 fps (0.1 to 6.1 m/s).
      3) Within 0.5 percent of actual reading at the calibrated velocity.
   e. Wet calibrate and tag sensors to standards traceable to NIST, and provide each sensor with a certificate of calibration.

2. Sensor:
   a. For Pipe Sizes NPS 2 (DN 50) and Smaller: Single turbine sensors.
b. For Pipe Sizes NPS 2-1/2 (DN 65) and Larger: Dual turbine sensors.
c. Piping with Bi-directional Flow: Bi-directional dual turbine sensors.
d. Dual turbine sensors shall have dual, contra-rotating turbine elements, each turbine
   element with its own rotational sensing system, and an averaging circuit.
e. Rotational sensing of each turbine shall be accomplished electronically by sensing
   electronic impedance change (non-magnetic and non-photoelectric).
f. Sensor shall have an integral frequency output linear with flow rate. For dual
   turbine units, with individual top and bottom turbine outputs for diagnostic
   purposes.
g. Bi-directional sensors shall have isolated solid-state dry contacts with a contact
   rating of 100 mA at 50 V. The contacts shall close when the flow in direction of
   arrow is 0.18 fps (0.05 m/s) or more.
h. Flow sensor shall be complete with installation hardware necessary to enable
   insertion and removal from pipe without system shutdown.
i. Construct turbine elements of polypropylene with sapphire jewel bearings and
   tungsten carbide shafts. Construct wetted metal components of Type 316 stainless
   steel, including installation hardware.
j. House sensor electronics in a NEMA 250, Type 4 enclosure.
k. Enclosure shall include connection(s) for field-installed conduit.
l. Sensor shall have cable of length sufficient to connect to display module.
m. Sensor housing shall have full port ball valve for system isolation.

3. Display Module:
   a. Remote from sensor.
   b. House in a NEMA 250, Type 4X enclosure.
   c. Label terminal strip for all wiring connections.
   d. 120-V ac power supply with 24-V dc output to power the flow sensor.
   e. Remote Interface:
      1) Hardwired Analog Outputs for Flow Rate and Totalization: 4 to 20 mA and
         zero- to 10-V dc.
      2) Serial Communication Interface: Compatible with host to share flow rate
         and totalized flow data.
      3) Outputs linear to within 0.1 percent of calibrated span.
   f. Digital display for flow rate and totalized flow.
      1) At least eight display digits for totalization.
      2) Bi-directional units with separate digital display for flow and totalization in
         each direction.
   g. Local reset of flow totalization.
   h. Program and data shall be stored in nonvolatile memory in event of power loss.
   i. For bi-directional units, with display of flow direction (contacts open or closed).

D. Inline Turbine Flow Meter:
   1. Description:
b. Operating pressure of 300 psig (2068 kPa) with a temperature of 200 deg F (93 deg C).
c. Meters in hot water systems shall be suitable for maximum system temperatures encountered, but not less than 250 deg F (121 deg C).
d. Pressure drop not to exceed 3 psig at 38 gpm (21 kPa at 2.4 L/s).
e. Sensor Accuracy:
   1) Within 2 percent of actual flow between the flow range of 0.8 to 38 gpm (0.05 to 2.4 L/s).
   2) Within 0.5 percent of actual reading at the calibrated velocity.
f. Wet calibrate and tag sensors to standards traceable to NIST, and provide each sensor with a certificate of calibration.

2. Sensor:
   a. Rotational sensing of turbine shall be accomplished electronically by sensing electronic impedance change (non-magnetic and non-photoelectric).
   b. Sensor shall have an integral frequency output linear with flow rate.
   c. Sensor shall have threaded union on each end.
   d. Construct turbine elements of polypropylene with sapphire jewel bearings and tungsten carbide shafts.
   e. Construct wetted metal components of brass or stainless steel.
   f. House sensor electronics in a NEMA 250, Type 4 enclosure.
   g. Enclosure shall include connection(s) for field-installed conduit.
   h. Sensor shall have cable of length sufficient to connect to display module.

3. Display Module:
   a. Remote from sensor.
   b. Enclosure: NEMA 250, Type 4X.
   c. Label terminal strip for all wiring connections.
   d. 120-V ac power supply with 24-V dc output to power the flow sensor.
   e. Remote Interface:
      1) Hardwired Analog Outputs for Flow Rate and Totalization: 4 to 20 mA and zero- to 10-V dc.
      2) Serial Communication Interface: Compatible with host to share flow rate and totalized flow data.
      3) Outputs linear to within 0.1 percent of calibrated span.
   f. Digital display of flow rate and totalized flow.
   g. At least eight display digits for totalization.
   h. Local reset of flow totalization.
   i. Program and data shall be stored in nonvolatile memory in the event of power loss.
2.7 LIQUID FLOW SENSORS (PRIMARY ELEMENTS)

A. Venturis:
   1. On request, submit independent testing documentation (product test reports),
      demonstrating compliance with specified performance.
   2. Standard: ASME MFC-3M.
   3. Performance:
      a. Accuracy within 0.5 percent of measured flow throughout flow range from design
         to 10 percent of design flow.
      b. Accuracy with five pipe diameters of straight pipe upstream and two pipe
         diameters downstream.
      c. Size and beta ratio shall be matched with transmitter to provide accuracy of entire
         assembly within 1 percent of design flow rate, when the flow rate is allowed to
         vary between 10 to 100 percent of the design.
   4. Construction:
      a. One-piece bronze or brass construction with threaded connections for pipe sizes
         NPS 1/2 through NPS 2 (DN 15 to DN 50).
      b. One-piece plated cast steel with flanged connections for pipe sizes NPS 2-1/2
         through NPS 8 (DN 65 to DN 200), and fabricated steel with flanged connections
         for larger sizes.
      c. Sensing Taps: Two, accurately located built-in sensing taps, nipples, shut-off
         valves, and quick connect coupling.
      d. Identification Tag: Attached to each venturi with a chain and label indicating pipe
         size, venturi series, station identification, and meter reading at flow rate and
         pressure differential.
      e. Use venturi with pressure differential transmitter.

B. Orifice Plates:
   1. Standards: ASME MFC-3M or ASME MFC-14M.
   2. Performance:
      a. Orifice plates shall be sharp, square-edged concentric type.
      b. Shop fabricate and calibrate orifice meter runs through NPS 2 (DN 50).
      c. Field fabricate orifice runs NPS 3 (DN 80) and larger.
      d. Meter run piping or tubing shall be uniform internal surface, which is free of
         internal grooves and striations, but is not polished. Out of roundness shall not
         exceed 0.5 percent. A reduction of the pipe diameter or distortion caused by
         welding is unacceptable.
      e. Size orifice plates for 100-inch wg (24.9-kPa) pressure differential, except that the
         absolute value of the meter range shall not exceed the absolute value of the flowing
         pressure.
      f. Ratio of orifice diameter to actual internal pipe diameter d/B (beta) shall be
         between 0.70 and 0.30.
      g. Locate orifice plates in horizontal or vertical lines in accordance with good
         metering practice.
h. Minimum upstream and downstream straight pipe shall comply with ASME Fluid Meters Research Committee Reports.

3. Construction:
   a. Fabricate the orifice plate and matching companion flanges of Type 316 stainless steel.
   b. Transmitter connection shall be at least NPS 1/2 (DN 15).
   c. Stamp the orifice plates with the number and the orifice bore on the handle of the plate.

4. Use orifice plate with pressure differential transmitter.

5. Calibration information and calculations shall comply with either of the referenced standards for each orifice plate.

C. Portable Meter Package for Liquid Flow Sensors:

1. Metal-reinforced-plastic carrying case.
2. Waterproof meter with nominal 6-inch (150-mm) round dial face.
4. Meter with external range and zero adjustment.
5. Multiple meters in package, if required to accommodate venturis with a wide range of pressure signals.
6. Two connecting hoses, 10-feet (3-m) long, with quick connect couplings compatible with venturi couplings.
7. Two brass blowdown valves with Buna-N seals and blowdown hoses.
9. Suitable for working pressure of 200 psig (1380 kPa) at 200 deg F (93.3 deg C).
10. Portable meter package to connect to flow sensor without disturbing connection to pressure differential transmitter. Provide isolation valves at connections.
11. Turn over to Owner at Project completion.

2.8 LIQUID FLOW SWITCHES

A. Liquid Flow Switch (Bellows Type):

1. Description:
   a. Field-adjustable four-vane combinations.
   b. Field-adjustable set-point adjustment screw.
   c. Suitable for pipe sizes NPS 1 through NPS 8DN 25 through DN 200.
   d. Switch mounted vertically in horizontal pipe.

2. Performance:
   a. Flow Rate Actuation and De-actuation: Varies with vane combination and set-point adjustment.
   b. Pressure Limit: 145 psig (1000 kPa).
c. Temperature Limit: 230 deg F (110 deg C).
d. Electrical Rating: 10 A resistive, 3 A conductive at 250-V ac.
e. Switch Type: SPDT snap switch.

3. Wetted Parts Construction:
   b. Vanes: Stainless steel.
   c. Body: Forged brass.

4. Enclosure:
   a. Die-cast aluminum alloy.
   b. NEMA 250, Type 4.
   c. Electrical Connection: Cable gland with attached wire leads.

B. Liquid Flow Switch (Magnetic Type):

1. Description:
   a. Field-adjustable five-vane combinations.
   b. Suitable for pipe sizes NPS 1-1/2 through NPS 20 (DN 40 to DN 500).
   c. Mounting Suitable for Application: Switch vertically mounted in horizontal pipe, or switch horizontally mounted in vertical pipe with flow up.
   d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous-environment Class I, Groups C and D; Class II, Groups E, F, and G.

2. Performance:
   a. Flow Rate Actuation and De-actuation: Varies with vane combination.
   b. Pressure Limit: 1000 psig (6895 kPa) for brass body, 2000 psig (13790 kPa) for Type 316 stainless-steel body.
   c. Temperature Range: Minus 4 to plus 275 deg F (Minus 20 to plus 135 deg C).
   d. Electrical Rating: 10 A at 125/250-V ac.
   e. Switch Type: DPDT snap switch.

3. Wetted Parts Construction:
   a. Vanes: Type 316 stainless steel.
   b. Body: Type 316 stainless steel.
   c. Magnetic Keeper: Type 316 stainless steel.

4. Enclosure:
   a. Die-cast aluminum alloy.
   b. Threaded cover.
   c. NEMA 250, Type 4.
d. Electrical Connection: Terminal block.
e. Conduit Connection: 3/4-inch (21-mm) trade size.

2.9 LIQUID FLOW TRANSMITTERS

A. Liquid Pressure Differential Transmitter for Flow Measurement:

1. Performance:
   a. Range: Approximately 2 times the set point.
   b. Span: Adjustable plus or minus 1 mA, non-interactive.
   c. Accuracy: Within 0.25 percent of full scale.
   d. Maximum Operating Pressure: 2.5 times range.
   e. Temperature Limits: Zero to 175 deg F (Minus 18 to plus 79 deg C).
   f. Compensate Temperature Limits: 30 to 150 deg F (Minus 1 to plus 66 deg C).
   g. Thermal Effects: 0.02 percent of full scale per degree F.
   h. Response Time: 30 to 50 ms.
   i. Shock and vibration shall not harm the transmitter.

2. Analog Output Current Signal:
   a. Two wire, 4- to 20-mA dc current source.
   b. Signal capable of operating into 1000-ohm load.

3. Operator Interface:
   a. Zero and span adjustments located behind cover.
   b. Bleed screws on side of body, two screws on low-pressure side and one screw on high-pressure side, for air in line and pressure cavity.

4. Construction:
   a. Aluminum and stainless-steel enclosure with removable cover.
   b. Wetted parts of transmitter constructed of 17-4 PH or 300 series stainless steel.
   c. NPS 1/4 (DN 8) process connections on side of instrument enclosure.
   d. Knock out for 1/2-inch (15-mm) trade size conduit connection on side of instrument enclosure.
   e. Screw terminal block for wire connections.
   f. NEMA 250, Type 4X.
   g. Mounting bracket shall be suitable for installation.

5. Transmitter shall have three-valve manifold. Construct manifold of brass, bronze, or stainless steel. Manifold shall have NPS 1/4 (DN 8) process connections.
PART 3 - EXECUTION

3.1 INSTRUMENT APPLICATIONS

A. Select from instrument types to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.

B. Duct-Mounted Airflow Sensors:
   1. Measured Velocities 500 fpm (2.5 m/s) and Less: Thermal airflow station.
   2. Measured Velocities Greater than 500 fpm (2.5 m/s): Pitot-tube airflow sensor station.

C. Damper-Mounted Airflow Sensors:
   1. Measured Velocities 400 fpm (2.0 m/s) and Less: Thermal airflow station.
   2. Measured Velocities Greater than 500 fpm (2.5 m/s): Pitot-tube airflow sensor station.

D. Fan-Mounted Airflow Sensors:
   1. Measured Velocities 500 fpm (2.5 m/s) and Less: Thermal airflow station.
   2. Measured Velocities Greater than 500 fpm (2.5 m/s): Thermal airflow station.

E. Airflow Switches:
   1. Measured Velocities 400 fpm (2.0 m/s) and Less: Polymer film sail switch.

F. Airflow Transmitters for Use with Pitot-Tube-Type Sensors:
   1. Exhaust Air Airflow: Pressure differential transmitter for airflow measurement.
   2. Outdoor Air Airflow: Pressure differential transmitter for airflow measurement.
   3. Return Air Airflow: Pressure differential transmitter for airflow measurement.
   4. Supply Air Airflow: Pressure differential transmitter for airflow measurement.

3.2 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy more stringent of all requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Properly support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a 1.5 force.

D. Install ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
E. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.3 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

A. Mounting Location:

1. Rough-in: Outline instrument-mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.

2. Install switches and transmitters for air and liquid flow associated with individual air-handling units and connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.

3. Install liquid and steam flow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.

4. Install airflow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.

5. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

6. Install instruments in steam, liquid, and liquid-sealed-piped services below their process connection point. Slope tubing down to instrument with a slope of 2 percent.

7. Install instruments in dry gas and non-condensable-vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of 2 percent.

B. Mounting Height:

1. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
2. Mount switches and transmitters, located in mechanical equipment rooms and other similar space not subject to code, state, and federal accessibility requirements, within a range of 42 to 72 inches (1050 to 1800 mm) above the adjacent floor, grade, or service catwalk or platform.
   
   a. Make every effort to mount at 60 inches (1500 mm).

C. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

3.5 FLOW INSTRUMENTS INSTALLATION

A. Airflow Sensors:
   
   1. Install sensors in straight sections of duct with manufacturer-recommended straight duct upstream and downstream of sensor.
   2. Installed sensors shall be accessible for visual inspection and service. Install access door(s) in duct or equipment located upstream of sensor, to allow service personnel to hand clean sensors.

B. Liquid and Steam Sensors:
   
   1. Install sensors in straight sections of piping with manufacturer-recommended straight piping upstream and downstream of sensor.
   2. Alert manufacturer where installation cannot accommodate recommended clearance, and solicit recommendations for field modifications to installation, such as flow straighteners, to improve condition.
   3. Install pipe reducers for in-line sensors smaller than line size. Position reducers at distance from sensor to avoid interference and impact on accuracy.
   4. Install in-line sensors with flanges or unions to provide drop-in and -out installation.

C. Liquid Flow Meters:
   
   1. Install meters in straight sections of piping with manufacturer-recommended straight piping upstream and downstream of sensor.
   2. Install pipe reducers for in-line meters smaller than line size. Install reducers at distance from meter to avoid interference and impact on accuracy.
   3. Install in-line meters with flanges or unions to provide drop-in and -out installation.
   4. Insertion Meters:
      
      a. Install system process connections full size of meter connection, but not less than NPS 2 (DN 50). Provide stainless-steel bushing if required to mate to system connection.
      b. Install meter in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement.
      c. In applications where top-dead-center location is not possible due to field constraints, install meter at location along top half of pipe if acceptable by manufacturer for mounting orientation.
D. Liquid Switches:
   1. Install system process connection full size of switch connection, but not less than NPS 2 (DN 50). Install stainless-steel bushing if required to mate switch to system connection.
   2. Install switch in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement.
   3. In applications where top-dead-center location is not possible due to field constraints, install switch at location along top half of pipe if switch is acceptable by manufacturer for mounting orientation.

E. Transmitters:
   1. Install airflow transmitters serving an air system in a single location adjacent to or within system control panel.
   2. Install liquid flow transmitters, not integral to sensors, in vicinity of sensor. Where multiple flow transmitters serving same system are located in same room, co-locate transmitters by system to provide service personnel a single and convenient location for inspection and service.

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification and on face of ceiling directly below instruments concealed above ceilings.

3.7 CHECKOUT PROCEDURES

A. Description:
   1. Check out installed products before continuity tests, leak tests, and calibration.
   2. Check instruments for proper location and accessibility.
   3. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
   4. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

B. Flow Instrument Checkout:
   1. Verify that sensors are installed correctly with respect to flow direction.
   2. Verify that sensor attachment is properly secured and sealed.
   3. Verify that processing tubing attachment is secure and isolation valves have been provided.
   4. Inspect instrument tag against approved submittal.
5. Verify that recommended upstream and downstream distances have been maintained.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

B. Coordinate video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

C. Record videos on DVD disks.

D. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION 23 09 23.14
SECTION 23 09 23.27 - TEMPERATURE INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Air temperature sensors.
   2. Air temperature switches.
   3. Air temperature RTD transmitters.
   4. Liquid temperature switches.

B. Related Requirements:
   1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.
   4. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Environmental Conditions:

1. Instruments shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.

   a. If instrument alone cannot meet requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, filtered, and ventilated as required by instrument and application.

2. Instruments and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Instrument's installed location shall dictate following NEMA 250 enclosure requirements:

   a. Outdoors, Protected: Type 3.
   b. Outdoors, Unprotected: Type 4X.
   c. Indoors, Heated with Filtered Ventilation: Type 2.
   d. Indoors, Heated with Non-Filtered Ventilation: Type 12.
   e. Indoors, Heated and Air Conditioned: Type 1.
   f. Mechanical Equipment Rooms:

      1) Boiler Rooms: Type 4.
      2) Air-Moving Equipment Rooms: Type 2.

   g. Localized Areas Exposed to Washdown: Type 4X.
   h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 3.
   i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4X.

2.2 AIR TEMPERATURE SENSORS

A. Platinum RTDs: Common Requirements:

1. 100 or 1000 ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
2. Two-wire, PTFE-insulated, 22-gage stranded copper leads.
3. Performance Characteristics:

   a. Range: Minus 50 to 275 deg F (Minus 46 to 135 deg C).
b. Interchangeable Accuracy: At 32 deg F (zero deg C) within 0.5 deg F (0.3 deg C).
c. Repeatability: Within 0.5 deg F (0.3 deg C).

4. Transmitter Requirements:
   a. Transmitter required for each 100-ohm RTD.
   b. Transmitter optional for 1000-ohm RTD, contingent on compliance with end-to-end control accuracy.

B. Platinum RTD, Single-Point Air Temperature Duct Sensors:
   1. 100 or 1000 ohms.
   2. Temperature Range: Minus 50 to 275 deg F (Minus 45 to 135 deg C).
   4. Length: As required by application to achieve tip at midpoint of air tunnel, up to 18 inches (450 mm) long).
   5. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
   6. Gasket for attachment to duct or equipment to seal penetration airtight.
   7. Conduit Connection: 1/2-inch (16-mm) trade size.)

C. Platinum RTD, Air Temperature Averaging Sensors:
   1. 100 or 1000 ohms.
   2. Temperature Range: Minus 50 to 275 deg F (Minus 45 to 135 deg C).
   3. Multiple sensors to provide average temperature across entire length of sensor.
   4. Rigid probe of aluminum, brass, copper, or stainless-steel sheath.
   5. Flexible probe of aluminum, brass, copper, or stainless-steel sheath and formable to a 4-inch (100-mm) radius.
   6. Length: As required by application to cover entire cross section of air tunnel.
   7. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
   8. Gasket for attachment to duct or equipment to seal penetration airtight.
   9. Conduit Connection: 1/2-inch ((16-mm) trade size.)

D. Platinum RTD Outdoor Air Temperature Sensors:
   1. 100 or 1000 ohms.
   2. Temperature Range: Minus 50 to 275 deg F ((Minus 45 to 135 deg C).)
   5. Enclosure: NEMA 250, Type 4 or 4X junction box or combination conduit and outlet box with removable cover and gasket.
   6. Conduit Connection: 1/2-inch (16-mm) trade size.

E. Platinum RTD Space Air Temperature Sensors:
   1. 100 or 1000 ohms.
   2. Temperature Range: Minus 50 to 212 deg F ((Minus 45 to 100 deg C).)

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3. Sensor assembly shall include a temperature sensing element mounted under a flush, brushed aluminum cover.
4. Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
5. Concealed wiring connection.

F. Thermal Resistors (Thermistors): Common Requirements:
   1. 10,000 ohms at 25 deg C and a temperature coefficient of 23.5 ohms/ohm/deg C.
   2. Two-wire, PTFE-insulated, 22-gage stranded copper leads.
   3. Performance Characteristics:
      a. Range: Minus 50 to 275 deg F (Minus 46 to 135 deg C).
      b. Interchangeable Accuracy: At 77 deg F (25 deg C) within 0.5 deg F (0.3 deg C).
      c. Repeatability: Within 0.5 deg F (0.3 deg C).
      d. Drift: Within 0.5 deg F (0.3 deg C) over 10 years.
      e. Self-Heating: Negligible.

4. Transmitter optional, contingent on compliance with end-to-end control accuracy.

G. Thermistor, Single-Point Duct Air Temperature Sensors:
   1. Temperature Range: Minus 50 to 275 deg F ((Minus 45 to 135 deg C)).
   2. Probe: Single-point sensor with a stainless-steel sheath.
   3. Length: As required by application to achieve tip at midpoint of air tunnel, up to 18 inches ((450 mm) long).
   4. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
   5. Gasket for attachment to duct or equipment to seal penetration airtight.
   6. Conduit Connection: 1/2- inch (16-mm) trade size.

H. Thermistor Averaging Air Temperature Sensors:
   1. Temperature Range: Minus 50 to 275 deg F (Minus 45 to 135 deg C).
   2. Multiple sensors to provide average temperature across entire length of sensor.
   3. Rigid probe of aluminum, brass, copper, or stainless-steel sheath.
   4. Flexible probe of aluminum, brass, copper, or stainless-steel sheath and formable to a 4-inch (100-mm) radius.
   5. Length: As required by application to cover entire cross section of air tunnel.
   6. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
   7. Gasket for attachment to duct or equipment to seal penetration airtight.
   8. Conduit Connection: 1/2-inch (16-mm) trade size.

I. Thermistor Outdoor Air Temperature Sensors:
   1. Temperature Range: Minus 50 to 275 deg F (Minus 45 to 135 deg C).
   2. Probe: Single-point sensor with a stainless-steel sheath.
4. Enclosure: NEMA 250, Type 4 or 4X junction box or combination conduit and outlet box with removable cover and gasket.
5. Conduit Connection: 1/2-inch (16-mm) trade size.

J. Thermistor Space Air Temperature Sensors:
   1. Temperature Range: Minus 50 to 212 deg F (Minus 45 to 100 deg C).
   2. Sensor assembly shall include a temperature sensing element mounted under a flush, brushed aluminum cover.
   3. Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.

K. Space Air Temperature Sensors for Use with DDC Controllers Controlling Terminal Units:
   1. 100- or 1000-ohm platinum RTD or thermistor.
   2. Thermistor:
      a. Pre-aged, burned in, and coated with glass; inserted in a metal sleeve; and entire unit encased in epoxy.
      b. Thermistor drift shall be less than plus or minus 0.5 deg F (0.3 deg C) over 10 years.
   3. Temperature Transmitter Requirements:
      a. Mating transmitter required with each 100-ohm RTD.
      b. Mating transmitters optional for 1000-ohm RTD and thermistor, contingent on compliance with end-to-end control accuracy.
   4. Provide digital display of sensed temperature.
   5. Provide sensor with local control.
      a. Local override to turn HVAC on.
      b. Local adjustment of temperature set point.
      c. Both features shall be capable of manual override through control system operator.

2.3 AIR TEMPERATURE SWITCHES

A. Thermostat and Switch for Low Temperature Control in Duct Applications:
   1. Description:
      a. Two-position control.
      b. Field-adjustable set point.
      d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Performance:
a. Operating Temperature Range: 15 to 55 deg F (Minus 9 to 13 deg C).
b. Temperature Differential: 5 deg F (2.8 deg C), non-adjustable and additive.
c. Enclosure Ambient Temperature: Minus 20 to 140 deg F (Minus 11 to 60 deg C).
d. Sensing Element Maximum Temperature: 250 deg F (121 deg C).
e. Voltage: 120-V ac.
f. Current: 16 FLA.
g. Switch Type: Two SPDT snap switches operate on coldest 12-inch (300-mm) section along element length.

3. Construction:
   a. Vapor-Filled Sensing Element: Nominal 20 feet (6 m) long.
   b. Dual Temperature Scale: Fahrenheit and Celsius visible on face.
   c. Set-Point Adjustment: Screw.
   d. Enclosure: Painted metal, NEMA 250, Type 1.
   e. Electrical Connections: Screw terminals.
   f. Conduit Connection: 1/2-inch (16-mm) trade size.

B. Thermostat and Switch for High Temperature Control in Duct Applications:

1. Source Limitations: Obtain temperature-measuring sensors and transmitters and airflow from single manufacturer.

2. Description:
   a. Two-position control.
   b. Field-adjustable set point.
   d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3. Performance:
   a. Temperature Range: 100 to 160 deg F (38 to 71 deg C).
   b. Temperature Differential: 5 deg F (2.8 deg C).
   c. Ambient Temperature: Zero to 260 deg F (Minus 18 to 127 deg C).
   d. Voltage: 120-V ac.
   e. Current: 16 FLA.
   f. Switch Type: SPDT snap switch.

4. Construction:
   b. Enclosure: Metal, NEMA 250, Type 1.
   c. Electrical Connections: Screw terminals.
   d. Conduit Connection: 1/2-inch (16-mm) trade size.
2.4 AIR TEMPERATURE RTD TRANSMITTERS

A. Source Limitations: Obtain temperature-measuring sensors and transmitters and airflow from single manufacturer.

B. House electronics in NEMA 250 enclosure.
   1. Duct: Type 3.
   2. Outdoor: Type 4X.
   3. Space: Type 1.

C. Conduit Connection: 1/2-inch ((16-mm) trade size.)

D. Functional Characteristics:
   1. Input:
      a. 100-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two-wire sensors.
      b. 1000-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two-wire sensors.
   2. Span (Adjustable):
      a. Space: 40 to 90 deg F (4 to 32 deg C).
      b. Supply Air Cooling and Heating: 40 to 120 deg F (4 to 49 deg C).
      c. Supply Air Cooling Only: 40 to 90 deg F (4 to 32 deg C).
      d. Supply Air Heating Only: 40 to 120 deg F (4 to 49 deg C).
      e. Exhaust Air: 50 to 100 deg F (10 to 38 deg C).
      f. Return Air: 50 to 100 deg F (10 to 38 deg C).
      g. Mixed Air: Minus 40 to 140 deg F (Minus 40 to 60 deg C).
      h. Outdoor: Minus 40 to 140 deg F (Minus 40 to 60 deg C).
   3. Output: 4- to 20-mA dc, linear with temperature; RFI insensitive; minimum drive load of 600 ohms at 24-V dc.
   4. Zero and span field adjustments, plus or minus 5 percent of span. Minimum span of 50 deg F (28 deg C).
   5. Match sensor with temperature transmitter and factory calibrate together.

E. Performance Characteristics:
   1. Calibration Accuracy: Within 0.1 percent of the span.
   2. Stability: Within 0.2 percent of the span for at least 6 months.
   3. Combined Accuracy: Within 0.5 percent.

2.5 LIQUID TEMPERATURE SWITCHES

A. Thermostat and Switch for Temperature Control in Pipe Applications:
1. Description:
   a. Two-position control.
   b. Field-adjustable set point.
   d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Performance:
   a. Operating Temperature Range: 65 to 200 deg F (18 to 3 deg C).
   b. Temperature Differential Deadband: 5 to 30 deg F (3 to 17 deg C), adjustable.
   c. Enclosure Ambient Temperature: 150 deg F (66 deg C).
   d. Sensing Element Pressure Rating: 200 psig (1379 kPa).
   e. Voltage: 120-V ac.
   f. Current: 8 FLA.
   g. Switch Type: SPDT snap switch.

3. Construction:
   a. Vapor-Filled Immersion Element: Copper, nominal 3 inches (75 mm) long.
   b. Temperature Scale: Fahrenheit, visible on face.
   c. Set-Point Adjustment: Screw.
   d. Enclosure: Painted metal, NEMA 250, Type 1.
   e. Electrical Connections: Screw terminals.
   f. Conduit Connection: 3/4-inch ((21-mm) trade size).

PART 3 - EXECUTION

3.1 TEMPERATURE INSTRUMENT APPLICATIONS

A. Air Temperature Sensors:
   1. Duct: Thermistor.
   2. Outdoor: Thermistor.

B. Air Temperature Transmitters:
   1. Duct: Air temperature RTD transmitter.
   2. Outdoor: Air temperature RTD transmitter.

C. Liquid and Temperature Transmitters:
   1. Hot Water System: Liquid temperature transmitter, commercial grade.
3.2 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a 1.5 force.

C. Fastening Hardware:
   1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
   2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
   3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

D. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

E. Corrosive Environments:
   1. Use products that are suitable for environment to which they are subjected.
   2. If possible, avoid or limit use of materials in corrosive environments.
   3. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
   4. Where instruments are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.3 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 TEMPERATURE INSTRUMENT INSTALLATIONS

A. Mounting Location:
1. Roughing In:
   a. Outline instrument mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
   b. Provide independent inspection to confirm that proposed mounting locations comply with requirements indicated and approved submittals.
      1) Indicate dimensioned locations with mounting height for all surface-mounted products on Shop Drawings.
      2) Do not begin installation without submittal approval of mounting location.
   c. Complete installation rough-in only after confirmation by independent inspection is complete and approval of location is documented for review by Owner and Architect on request.

2. Install switches and transmitters for air and liquid temperature associated with individual air-handling units and associated connected ductwork and piping near air-handling units co-located in air-handling unit system control panel to provide service personnel a single and convenient location for inspection and service.

3. Install liquid and steam temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.

4. Install air temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.

5. Mount switches and transmitters on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer's mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

B. Special Mounting Requirements:

1. Protect products installed outdoors from solar radiation, building and wind effect with stand-offs and shields constructed of Type 316 stainless.

2. Temperature instruments having performance impacted by temperature of mounting substrate shall be isolated with an insulating barrier located between instrument and substrate to eliminate effect. Where instruments requiring insulation are located in finished space, conceal insulating barrier in a cover matching the instrument cover.

C. Mounting Height:

1. Mount temperature instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.

2. Mount switches and transmitters located in mechanical equipment rooms and other similar space not subject to code or state and Federal accessibility requirements within a range of 42 to 72 inches (1.1 to 1.6 m) above the adjacent floor, grade, or service catwalk or platform.
   a. Make every effort to mount at 60 inches (1500 mm).
D. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

E. Space Temperature Sensor Installation:
   1. Conceal assembly in an electrical box of sufficient size to house sensor and transmitter, if provided.
   2. Install electrical box with a faceplate to match sensor cover if sensor cover does not completely cover electrical box.
   3. In finished areas, recess electrical box within wall.
   4. In unfinished areas, electrical box may be surface mounted if electrical light switches are surface mounted. Use a cast-aluminum electric box for surface-mounted installations.
   5. Align electrical box with other electrical devices such as visual alarms and light switches located in the vicinity to provide a neat and well-thought-out arrangement. Where possible, align in both horizontal and vertical axis.

F. Outdoor Air Temperature Sensor Installation:
   1. Mount sensor in a discrete location facing north.
   2. Protect installed sensor from solar radiation and other influences that could impact performance.
   3. If required to have a transmitter, mount transmitter remote from sensor in an accessible and serviceable location indoors.

G. Single-Point Duct Temperature Sensor Installation:
   1. Install single-point-type, duct-mounted, supply- and return-air temperature sensors. Install sensors in ducts with sensitive portion of the element installed in center of duct cross section and located to sense near average temperature. Do not exceed 24 inches (610 mm) in sensor length.
   2. Install return-air sensor in location that senses return-air temperature without influence from outdoor or mixed air.
   3. Rigidly support sensor to duct and seal penetration airtight.
   4. If required to have transmitter, mount transmitter remote from sensor at accessible and serviceable location.

H. Averaging Duct Temperature Sensor Installation:
   1. Install averaging-type air temperature sensor for temperature sensors located within air-handling units, similar equipment, and large ducts with air tunnel cross-sectional area of 20 sq. ft. (1.86 sq. m) and larger.
   2. Install sensor length to maintain coverage over entire cross-sectional area. Install multiple sensors where required to maintain the minimum coverage.
   3. Fasten and support sensor with manufacturer-furnished clips to keep sensor taut throughout entire length.
   4. If required to have transmitter, mount transmitter in an accessible and serviceable location.

I. Low-Limit Air Temperature Switch Installation:
1. Install multiple low-limit switches to maintain coverage over entire cross-sectional area of air tunnel.
2. Fasten and support sensing element with manufacturer-furnished clips to keep element taut throughout entire length.
3. Mount switches outside of airstream at a location and mounting height to provide easy access for switch set-point adjustment and manual reset.
4. Install on entering side of cooling coil unless otherwise indicated on Drawings.

J. Liquid Temperature Sensor Installation:

1. Assembly shall include sensor, thermowell and connection head.
2. For pipe NPS 4 (DN 100) and larger, install sensor and thermowell length to extend into pipe between 50 to 75 percent of pipe cross section.
3. For pipe smaller than NPS 4 (DN 100):
   a. Install reducers to increase pipe size to NPS 4 (DN 100) at point of thermowell installation.
   b. For pipe sizes NPS 2-1/2 and NPS 3 (DN 65 and DN 80), thermowell and sensor may be installed at pipe elbow or tee to achieve manufacturer-recommended immersion depth in lieu of increasing pipe size.
   c. Minimum insertion depth shall be 2-1/2 inches (65 mm).
4. Install matching thermowell.
5. Fill thermowell with heat-transfer fluid before inserting sensor.
6. Tip of spring-loaded sensors shall contact inside of thermowell.
7. For insulated piping, install thermowells with extension neck to extend beyond face of insulation.
8. Install thermowell in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement. If top dead center location is not possible due to field constraints, install thermowell at location along top half of pipe.
9. For applications with transmitters, mount transmitter remote from sensor in an accessible and serviceable location from floor.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification and on face of ceiling directly below instruments concealed above ceilings.

3.6 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.
B. Wash and shine glazing.
C. Polish glossy surfaces to a clean shine.

3.7 CHECK-OUT PROCEDURES
A. Check installed products before continuity tests, leak tests, and calibration.
B. Check temperature instruments for proper location and accessibility.
C. Verify sensing element type and proper material.
D. Verify location and length.
E. Verify that wiring is correct and secure.

3.8 FIELD QUALITY CONTROL
A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Perform according to manufacturer's written instruction.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
B. Prepare test and inspection reports.

3.9 ADJUSTING
A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.10 DEMONSTRATION
A. Train Owner's maintenance personnel to adjust, operate, and maintain temperature instruments.

END OF SECTION 23 09 23.27
PART 1 - GENERAL

1.1 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:

1. Hot-water heating piping.
2. Makeup-water piping.
3. Air-vent piping.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Plastic pipe and fittings with solvent cement.
2. RTRP and RTRF with adhesive.
3. Pressure-seal fittings.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services’ “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.”

C. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.
1.4 QUALITY ASSURANCE


PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

1. Hot-Water Heating Piping: 50 psig (345 kPa) at 200 deg F (93 deg C).
2. Makeup-Water Piping: 80 psig (552 kPa) at 150 deg F (66 deg C).
4. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L (ASTM B 88M, Type B).
B. Annealed-Temper Copper Tubing: ASTM B 88, Type K (ASTM B 88M, Type A).
C. DWV Copper Tubing: ASTM B 306, Type DWV.
   1. Grooved-End Copper Fittings: ASTM B 75 (ASTM B 75M), copper tube or ASTM B 584, bronze casting.
   2. Grooved-End-Tube Couplings: Rigid pattern unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves,[prelubricated] EPDM gasket rated for minimum 230 deg F (110 deg C) for use with housing, and steel bolts and nuts.
E. Wrought-Copper Unions: ASME B16.22.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.
B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.
D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.

F. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   2. End Connections: Butt welding.
   3. Facings: Raised face.

G. Grooved Mechanical-Joint Fittings and Couplings:
   1. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106/A 106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
   2. Couplings: Ductile- or malleable-iron housing and EPDM or nitrile gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

2.4 PLASTIC PIPE AND FITTINGS

A. CPVC Plastic Pipe: ASTM F 441/F 441M, with wall thickness as indicated in "Piping Applications" Article.

B. PVC Plastic Pipe: ASTM D 1785, with wall thickness as indicated in "Piping Applications" Article.

2.5 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness unless otherwise indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

F. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for Joining Plastic Piping:
   1. CPVC Piping: ASTM F 493.
      a. CPVC solvent cement shall have a VOC content of 490 g/L or less.
      b. Adhesive primer shall have a VOC content of 550 g/L or less.
      c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Health Services’) "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

   2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
      a. PVC solvent cement shall have a VOC content of 510 g/L or less.
      b. Adhesive primer shall have a VOC content of 550 g/L or less.
      c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Health Services’) "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

H. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.6 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings:
   1. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.

B. Plastic-to-Metal Transition Unions:
1. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.

2.7 DIELECTRIC FITTINGS
A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
B. Dielectric Unions:
   1. Description:
      b. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
      c. End Connections: Solder-joint copper alloy and threaded ferrous.

2.8 BYPASS CHEMICAL FEEDER
A. Description: Welded steel construction; 125-psig (860-kPa) working pressure; 5-gal. (19-L) capacity; with fill funnel and inlet, outlet, and drain valves.
   1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS
A. Hot-water heating piping, aboveground, NPS 2 (DN 50) and smaller, shall be the following:
   1. Type L (Type B), drawn-temper copper tubing, wrought-copper fittings, and \textbf{soldered} \textbf{[brazed] [pressure-seal]} joints.
B. Hot-water heating piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be the following:
   1. Type L (Type B), drawn-temper copper tubing, wrought-copper fittings, and \textbf{soldered} \textbf{[brazed]} joints.
C. Hot-Water Heating Piping Installed Belowground and within Slabs: Type K (Type A), annealed-temper copper tubing, wrought-copper fittings, and brazed joints. Use the fewest possible joints.
D. Makeup-water piping installed aboveground shall be the following:
   1. Type L (Type B), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
E. Makeup-Water Piping Installed Belowground and within Slabs: Type K (Type A), annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

F. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints or Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

G. Condensate-Drain Piping: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

H. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

I. Air-Vent Piping:
   1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
   2. Outlet: Type K (Type A), annealed-temper copper tubing with soldered or flared joints.

J. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.
J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

Q. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.

R. Install shutoff valve immediately upstream of each dielectric fitting.

S. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.3 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flange kits.

D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.4 HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:
1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet (6 m) long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet (6 m) or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4 (DN 20): Maximum span, 7 feet (2.1 m).
2. NPS 1 (DN 25): Maximum span, 7 feet (2.1 m).
3. NPS 1-1/2 (DN 40): Maximum span, 9 feet (2.7 m).
4. NPS 2 (DN 50): Maximum span, 10 feet (3 m).
5. NPS 2-1/2 (DN 65): Maximum span, 11 feet (3.4 m).
6. NPS 3 (DN 80) and Larger: Maximum span, 12 feet (3.7 m).

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4 (DN 20): Maximum span, 5 feet (1.5 m); minimum rod size, 1/4 inch (6.4 mm).
2. NPS 1 (DN 25): Maximum span, 6 feet (1.8 m); minimum rod size, 1/4 inch (6.4 mm).
3. NPS 1-1/4 ((DN 32):)Maximum span, 7 feet (2.1 m); minimum rod size, 3/8 inch (10 mm).
4. NPS 1-1/2 (DN 40): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
5. NPS 2 (DN 50): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
6. NPS 2-1/2 (DN 65): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8 inch (10 mm).
7. NPS 3 (DN 80) and Larger: Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (10 mm).

E. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

F. Support vertical runs at roof, at each floor, and at 10-foot (3-m) intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

G. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   3. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
   4. PVC Nonpressure Piping: Join according to ASTM D 2855.

H. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

I. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

3.6 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."
3.7 CHEMICAL TREATMENT

A. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

B. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 23 21 13
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   2. Automatic condensate pump units.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of pump.

B. Shop Drawings: For each pump.
   1. Show pump layout and connections.
   2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
   3. Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong Pumps, Inc.
   2. Bell & Gossett.
   3. Patterson Pump Company; a Gorman-Rupp company.
   4. TACO Comfort Solutions, Inc.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.

C. Capacities and Characteristics: See Pump Schedule on Drawings.

D. Pump Construction:
1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
5. Seal: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.

E. Motor: Single speed and rigidly mounted to pump casing.

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   a. Enclosure: Open, dripproof or totally enclosed, fan cooled.
   b. Enclosure Materials: Cast iron.
   d. Efficiency: Premium efficient.
   e. NEMA Design.

PART 3 - EXECUTION

3.1 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Equipment Mounting:

1. Install base-mounted pumps on cast-in-place concrete equipment base(s).
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
E. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and elastomeric hangers of size required to support weight of in-line pumps.

1. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.2 ALIGNMENT

A. Engage a factory-authorized service representative to perform alignment service.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to pump, allow space for service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install check and shutoff on discharge side of pumps.

F. Install Y-type strainer, flow straightener, and shutoff valve on suction side of pumps.

G. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.

H. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 23 21 23
SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Refrigerant pipes and fittings.
   2. Refrigerant piping valves and specialties.
   3. Refrigerants.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty.

B. Shop Drawings:
   1. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
   2. Show interface and spatial relationships between piping and equipment.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE


B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-134a:

B. Line Test Pressure for Refrigerant R-407C:

C. Line Test Pressure for Refrigerant R-410A:

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K or L (ASTM B 88M, Type A or B).

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8/A5.8M.

F. Flexible Connectors:
   2. End Connections: Socket ends.
   3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
   5. Maximum Operating Temperature: 250 deg F (121 deg C).
2.3 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
3. Operator: Rising stem and hand wheel.
5. End Connections: Socket, union, or flanged.

B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig (3.4 kPa).

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
4. End Connections: Copper spring.

E. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).

4. End Connections: Threaded.

5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and 24-V ac coil.


F. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.


4. End Connections: Threaded.


G. Thermostatic Expansion Valves: Comply with AHRI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.


4. Capillary and Bulb: Copper tubing filled with refrigerant charge.

5. Suction Temperature: 40 deg F (4.4 deg C).


7. Reverse-flow option (for heat-pump applications).

8. End Connections: Socket, flare, or threaded union.


H. Hot-Bas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

1. Body, Bonnet and Seal Cap: Ductile iron or steel.


5. Seat: Polytetrafluoroethylene.

6. Equalizer: Internal

7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with ½-inch (16-GRC) conduit adapter and 24-V ac coil.


I. Straight-Type Strainers:


2. Screen: 100-mesh stainless steel.

3. End Connections: Socket or flare.


J. Angle-Type Strainers:
   1. Body: Forged brass or cast bronze.
   2. Drain Plug: Brass hex plug.
   3. Screen: 100-mesh monel.
   4. End Connections: Socket or flare.

K. Moisture/Liquid Indicators:
   2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
   3. Indicator: Color coded to show moisture content in parts per million (ppm).
   5. End Connections: Socket or flare.

L. Replaceable-Core Filter Dryers: Comply with AHRI 730.
   1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
   2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
   4. Designed for reverse flow (for heat-pump applications).
   5. End Connections: Socket.
   7. Maximum Pressure Loss: 2 psig (14 kPa).

M. Permanent Filter Dryers: Comply with AHRI 730.
   2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
   4. Designed for reverse flow (for heat-pump applications).
   5. End Connections: Socket.
   7. Maximum Pressure Loss: 2 psig (14 kPa).
2.4 REFRIGERANTS

A. ASHRAE 34, R-134a: Tetrafluoroethane.

B. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.

C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-134a

A. Suction Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

C. Safety-Relief-Valve Discharge Piping: Copper, Type L (B), drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 PIPING APPLICATIONS FOR REFRIGERANT R-407C

A. Suction Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.

C. Safety-Relief-Valve Discharge Piping: Copper, Type L (B), drawn-temper tubing and wrought-copper fittings with soldered joints.

3.3 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type L (B), annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

D. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type L (B), drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
E. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type L (B), drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.

F. Safety-Relief-Valve Discharge Piping: Copper, Type L (B), annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

G. Safety-Relief-Valve Discharge Piping: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

H. Safety-Relief-Valve Discharge Piping: Copper, Type L (B), drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.

I. Safety-Relief-Valve Discharge Piping: Copper, Type L (B), drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.

3.4 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

E. Install a full-size, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:
1. Solenoid valves.
2. Thermostatic expansion valves.
3. Hot-gas bypass valves.
4. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.

L. Install receivers sized to accommodate pump-down charge.

M. Install flexible connectors at compressors.

3.5 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:
   1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
   2. Install horizontal suction lines with a uniform slope downward to compressor.
   3. Install traps and double risers to entrain oil in vertical runs.
   4. Liquid lines may be installed level.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

R. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."

3.6 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
   2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

3.7 HANGERS AND SUPPORTS

A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet (6 m) or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:

1. NPS 1/2 (DN 15): Maximum span, 60 inches (1500 mm); minimum rod, 1/4 inch (6.4 mm).
2. NPS 5/8 (DN 18): Maximum span, 60 inches (1500 mm); minimum rod, 1/4 inch (6.4 mm).
3. NPS 1 (DN 25): Maximum span, 72 inches (1800 mm); minimum rod, 1/4 inch (6.4 mm).
4. NPS 1-1/4 (DN 32): Maximum span, 96 inches (2400 mm); minimum rod, 3/8 inch (9.5 mm).
5. NPS 1-1/2 (DN 40): Maximum span, 96 inches (2400 mm); minimum rod, 3/8 inch (9.5 mm).
6. NPS 2 (DN 50): Maximum span, 96 inches (2400 mm); minimum rod, 3/8 inch (9.5 mm).
7. NPS 2-1/2 (DN 65): Maximum span, 108 inches (2700 mm); minimum rod, 3/8 inch (9.5 mm).
8. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod, 3/8 inch (9.5 mm).
9. NPS 4 (DN 100): Maximum span, 12 feet (3.7 m); minimum rod, 1/2 inch (13 mm).

D. Support multifloor vertical runs at least at each floor.

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
   a. Fill system with nitrogen to the required test pressure.
   b. System shall maintain test pressure at the manifold gage throughout duration of test.
   c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
   d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.
3.9 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
4. Charge system with a new filter-dryer core in charging line.

3.10 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 23 00
SECTION 23 25 13 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following water treatment for closed-loop hydronic systems:
   1. Automatic chemical-feed equipment.
   2. Chemicals.

1.2 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Closed hydronic systems shall have the following water qualities:
   1. pH: Maintain a value within 9.0 to 10.5.
   2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
   3. Boron: Maintain a value within 100 to 200 ppm.
   4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
   5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
   6. TSS: Maintain a maximum value of 10 ppm.
   9. Microbiological Limits:
      a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/mL.
      b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.
      c. Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.
      d. Sulfate Reducers: Maintain a maximum value of zero organisms/mL.
e. Iron Bacteria: Maintain a maximum value of zero organisms/mL.

2.2 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch (89-mm) fill opening in the top, and NPS 3/4 (DN 20) bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.

1. Capacity: 2 gal. (7.6 L).

2.3 AUTOMATIC CHEMICAL-FEED EQUIPMENT

A. Water Meter:

1. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
2. Body: Bronze.
5. Registration: Gallons (Liters) or cubic feet (cubic meters).
7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow.
8. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
2. Molded cover with recess for mounting pump.

C. Chemical Solution Injection Pumps:

1. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
2. Adjustable flow rate.
3. Metal and thermoplastic construction.
5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
D. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.

E. Injection Assembly:
   1. Quill: Minimum NPS 1/2 (DN 15) with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
   2. Ball Valve: Two-piece, stainless steel; selected to fit quill.
   3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
   4. Assembly Pressure/Temperature Rating: Minimum 600 psig (4137 kPa) at 200 deg F (93 deg C).

2.4 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

B. Install water testing equipment on wall near water chemical application equipment.

C. Install interconnecting control wiring for chemical treatment controls and sensors.

D. Mount sensors and injectors in piping circuits.

E. Bypass Feeders: Install in closed hydronic systems, including hot-water heating, and equipped with the following:
   1. Install bypass feeder in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.
   2. Install water meter in makeup-water supply.
   3. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below the feeder inlet.
5. Install a swing check on the inlet after the isolation valve.

F. Where installing piping adjacent to equipment, allow space for service and maintenance.

G. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Comply with requirements in Section 232116 "Hydronic Piping Specialties"

H. Install shutoff valves on HVAC water-treatment equipment inlet and outlet.

I. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.

J. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

K. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

L. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials and retest piping until no leaks exist.

B. Equipment will be considered defective if it does not pass tests and inspections.
C. Prepare test and inspection reports.

END OF SECTION 23 25 13
SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular ducts and fittings.
2. Round ducts and fittings.
4. Sealants and gaskets.
5. Hangers and supports.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:
1. Product Data for Prerequisite IEQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1, Section 5 – “Systems and Equipment.”
2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1, Section 6.4.4–“HVAC System Construction and Insulation.”
3. Duct-Cleaning Test Report for Prerequisite IEQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 – “Ventilation System Start-up.”
4. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
5. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation including printed statement of VOC content.
6. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services’ “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.”

C. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

D. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports.
1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.
   f. Perimeter moldings.

B. Welding certificates.

1.5 QUALITY ASSURANCE


B. Welding Qualifications: Qualify procedures and personnel according to the following:


C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Round, Oval, and Flexible Duct," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches (1524 mm) in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger Than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60 (Z180).
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

G. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.4 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:
   1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
   2. Tape Width: 4 inches (102 mm).
   5. Mold and mildew resistant.
   6. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
   7. Service: Indoor and outdoor.
C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

2. Type: S.
3. Grade: NS.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m) and shall be rated for 10-inch wg (2500-Pa) static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:
   3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
H. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.


3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
   5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (5 m).

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.

2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.

3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.

2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).

2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.


5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.


7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.

3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.

5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

6. Provide drainage and cleanup for wash-down procedures.

7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.7 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.8 DUCT SCHEDULE

A. See ductwork schedule on drawings.

B. Intermediate Reinforcement:


2. PVC-Coated Ducts:
   a. Exposed to Airstream: Match duct material.
   b. Not Exposed to Airstream: Galvanized.

3. Stainless-Steel Ducts:
   a. Exposed to Airstream: Match duct material.
   b. Not Exposed to Airstream: Galvanized.


C. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
   a. Velocity 1000 fpm (5 m/s) or Lower:
      1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      2) Mitered Type RE 4 without vanes.
   b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s):
      1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm (7.6 m/s) or Higher:
1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
   c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

   1) Velocity 1000 fpm (5 m/s) or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
   2) Velocity 1000 to 1500 fpm (5 to 7.6 m/s): 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
   3) Velocity 1500 fpm (7.6 m/s) or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
   4) Radius-to-Diameter Ratio: 1.5.

   b. Round Elbows, 12 Inches (305 mm) and Smaller in Diameter: Stamped or pleated.
   c. Round Elbows, 14 Inches (356 mm) and Larger in Diameter: Standing seam.

D. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   b. Rectangular Main to Round Branch: Spin in.
2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

   a. Velocity 1000 fpm (5 m/s) or Lower: 90-degree tap.
   b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap.
   c. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral.

END OF SECTION 23 31 13
SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
3. Control dampers.
4. Fire dampers.
5. Smoke dampers.
6. Flange connectors.
7. Turning vanes.
8. Duct-mounted access doors.
10. Flexible ducts.
11. Duct accessory hardware.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 – “Systems and Equipment.”
2. Product Data for Prerequisite EA 2: Documentation indicating that duct insulation R-values comply with tables in ASHRAE/IESNA 90.1, Section 6 – “Heating, Ventilating, and Air Conditioning.”

C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

   a. Special fittings.
   c. Control-damper installations.
   d. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.
   e. Wiring Diagrams: For power, signal, and control wiring.
1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION


B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60 (Z180).
   2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.


E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Description: Gravity balanced.

B. Maximum Air Velocity: 1250 fpm (6.4 m/s).

C. Maximum System Pressure: 3-inch wg (0.8 kPa).

D. Frame: Hat-shaped, 0.094-inch- (2.4-mm-) thick, galvanized sheet steel, with welded corners or mechanically attached and mounting flange.
E. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch (150-mm) width, 0.050-inch-(1.2-mm-) thick aluminum sheet with sealed edges.

F. Blade Action: Parallel.

G. Blade Seals: Extruded vinyl, mechanically locked.

H. Blade Axles:
   1. Material: Aluminum.
   2. Diameter: 0.20 inch (5 mm).

I. Tie Bars and Brackets: Galvanized steel.

J. Return Spring: Adjustable tension.

K. Bearings: Steel ball or synthetic pivot bushings.

L. Accessories:
   1. Adjustment device to permit setting for varying differential static pressure.
   2. Counterweights and spring-assist kits for vertical airflow installations.
   3. Electric actuators.
   4. Chain pulls.
   5. Screen Mounting: Front mounted in sleeve.
      a. Sleeve Thickness: 20 gage (1.0 mm) minimum.
      b. Sleeve Length: 6 inches (152 mm) minimum.
   6. Screen Mounting: Rear mounted.
   7. Screen Material: Aluminum.
   8. Screen Type: Insect.
   9. 90-degree stops.

2.4 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:
   1. Standard leakage rating, with linkage outside airstream.
   2. Suitable for horizontal or vertical applications.
   3. Frames:
      a. Frame: Hat-shaped, 0.05-inch- (1.3-mm-) thick stainless steel.
      b. Mitered and welded corners.
      c. Flanges for attaching to walls and flangeless frames for installing in ducts.
   4. Blades:
      a. Multiple or single blade.
      b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Galvanized-steel, 0.064 inch (1.62 mm) thick.

6. Bearings:
   a. Oil-impregnated bronze.
   b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

7. Tie Bars and Brackets: Galvanized steel.

B. Standard, Aluminum, Manual Volume Dampers:
   1. Standard leakage rating, with linkage outside airstream.
   2. Suitable for horizontal or vertical applications.
   3. Frames: Hat-shaped, 0.10-inch- (2.5-mm-) thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
   4. Blades:
      a. Multiple or single blade.
      b. Parallel- or opposed-blade design.
      c. Stiffen damper blades for stability.
      d. Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.
      e. Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.

6. Bearings:
   a. Oil-impregnated bronze.
   b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

7. Tie Bars and Brackets: Aluminum.

C. Jackshaft:
   1. Size: 0.5-inch (13-mm) diameter.
   2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
   3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware:
   1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm-) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut.
   2. Include center hole to suit damper operating-rod size.
   3. Include elevated platform for insulated duct mounting.
2.5 CONTROL DAMPERS

A. Frames:
   1. Hat shaped.
   2. 0.05-inch- (1.3-mm-) thick stainless steel.
   3. Mitered and welded corners.

B. Blades:
   1. Multiple blade with maximum blade width of 6 inches (152 mm).
   2. Parallel- and opposed-blade design.
   4. 0.064 inch (1.62 mm) thick single skin or 0.0747-inch- (1.9-mm-) thick dual skin.

C. Blade Axles: 1/2-inch- (13-mm-) diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
   1. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).

D. Bearings:
   1. Oil-impregnated bronze.
   2. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
   3. Thrust bearings at each end of every blade.

2.6 FIRE DAMPERS

A. Type: Static and dynamic; rated and labeled according to UL 555 by an NRTL.

B. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 2000-fpm (10-m/s) velocity.

C. Fire Rating: 3 hours.

D. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   1. Minimum Thickness: 0.138 inch (3.5 mm) or 0.39 inch (9.9 mm) thick, as indicated, and of length to suit application.
   2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

I. Heat-Responsive Device: Replaceable, 212 deg F (100 deg C) rated, fusible links.

J. Heat-Responsive Device: Replaceable link and switch package, factory installed, 165 deg F (74 deg C) and 212 deg F (100 deg C) rated.

2.7 SMOKE DAMPERS

A. General Requirements: Label according to UL 555S by an NRTL.

B. Smoke Detector: Integral, factory wired for single-point connection.

C. Frame: Hat-shaped, 0.094-inch- (2.4-mm-) thick, galvanized sheet steel, with interlocking, gusseted or mechanically attached corners and mounting flange.

D. Blades: Roll-formed, horizontal, interlocking, 0.063-inch- (1.6-mm) thick, galvanized sheet steel.

E. Leakage: Class I.

F. Rated pressure and velocity to exceed design airflow conditions.

G. Mounting Sleeve: Factory-installed, 0.05-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

H. Damper Motors: Modulating or two-position action.

I. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.

4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).

6. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m).

7. Electrical Connection: 115 V, single phase, 60 Hz.

J. Accessories:

1. Auxiliary switches for signaling or position indication.
2. Test and reset switches, remote mounted.

2.8 FLANGE CONNECTORS

A. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

B. Material: Galvanized steel.

C. Gage and Shape: Match connecting ductwork.

2.9 TURNING VANES

A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.


B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vaners and Vane Runners," and 4-4, "Vane Support in Elbows."

C. Vane Construction: Single wall.

2.10 DUCT-MOUNTED ACCESS DOORS


1. Door:
   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Vision panel.
d. Hinges and Latches: 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.
e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
   a. Access Doors Less Than 12 Inches (300 mm) Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches (460 mm) Square: Two hinges and two sash locks.
   c. Access Doors up to 24 by 48 Inches (600 by 1200 mm): Three hinges and two compression latches with outside and inside handles.
   d. Access Doors Larger Than 24 by 48 Inches (600 by 1200 mm): Four hinges and two compression latches with outside and inside handles.

B. Pressure Relief Access Door:
   1. Door and Frame Material: Galvanized sheet steel.
   2. Door: Single wall with metal thickness applicable for duct pressure class.
   3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
   4. Factory set at 10-inch wg (2500 Pa).
   5. Doors close when pressures are within set-point range.
   6. Hinge: Continuous piano.
   7. Latches: Cam.
   8. Seal: Neoprene or foam rubber.
   9. Insulation Fill: 1-inch- (25-mm-) thick, fibrous-glass or polystyrene-foam board.

2.11 DUCT ACCESS PANEL ASSEMBLIES
A. Labeled according to UL 1978 by an NRTL.
B. Panel and Frame: Minimum thickness 0.0428-inch (1.1-mm) stainless steel.
C. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.
D. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F (1093 deg C).
E. Minimum Pressure Rating: 10-inch wg (2500 Pa), positive or negative.

2.12 FLEXIBLE CONNECTORS
A. Materials: Flame-retardant or noncombustible fabrics.
B. Coatings and Adhesives: Comply with UL 181, Class 1.
C. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches (146 mm) wide attached to two strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.

   1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
   2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
   3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
   1. Minimum Weight: 24 oz./sq. yd. (810 g/sq. m).
   2. Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
   3. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).

2.13 FLEXIBLE DUCTS

A. Noninsulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.
   1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
   2. Maximum Air Velocity: 4000 fpm (20 m/s).
   3. Temperature Range: Minus 10 to plus 160 deg F (Minus 23 to plus 71 deg C).

B. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
   1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
   2. Maximum Air Velocity: 4000 fpm (20 m/s).
   3. Temperature Range: Minus 20 to plus 210 deg F (Minus 29 to plus 99 deg C).
   4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

C. Flexible Duct Connectors:
   1. Clamps: Nylon strap in sizes 3 through 18 inches (75 through 460 mm), to suit duct size.

2.14 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
   1. Install steel volume dampers in steel ducts.
   2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Upstream and downstream from duct filters.
   3. At outdoor-air intakes and mixed-air plenums.
   4. At drain pans and seals.
   5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
   7. At each change in direction and at maximum 50-foot (15-m) spacing.
   8. Upstream and downstream from turning vanes.
   9. Upstream or downstream from duct silencers.
   10. Control devices requiring inspection.
11. Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.

J. Access Door Sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
   2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
   3. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
   4. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).

K. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

L. Install flexible connectors to connect ducts to equipment.

M. Connect terminal units to supply ducts directly or with maximum 12-inch (300-mm) lengths of flexible duct. Do not use flexible ducts to change directions.

N. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch (1500-mm) lengths of flexible duct clamped or strapped in place.

O. Connect flexible ducts to metal ducts with liquid adhesive plus tape.

P. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.
   3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
   4. Inspect turning vanes for proper and secure installation.

END OF SECTION 23 33 00
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: For each product.

1. Backward-inclined centrifugal fans.
2. Forward-curved centrifugal fans.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Include rated capacities, furnished specialties, and accessories for each fan.
2. Certified fan performance curves with system operating conditions indicated.
3. Certified fan sound-power ratings.
4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
5. Material thickness and finishes, including color charts.
6. Dampers, including housings, linkages, and operators.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

B. Field quality-control reports.
1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Belts: Two sets for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AMCA Compliance: Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.

B. Capacities and Characteristics:

1. See schedule on drawings.
2. Vibration Isolators: Restrained spring isolators having a static deflection of 1 inch (25 mm).
3. Spark-Resistance Class: A.

2.2 BACKWARD-INCLINED CENTRIFUGAL FANS

A. Greenheck, Cook, Penn

B. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

C. Housings:

1. Formed panels to make curved-scroll housings with shaped cutoff.
2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
3. Horizontally split, bolted-flange housing.
4. Spun inlet cone with flange.
5. Outlet flange.
D. Backward-Inclined Wheels:
   1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades, and fastened to shaft with set screws.
   2. Welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate.

E. Shafts:
   1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
   2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
   3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Grease-Lubricated Shaft Bearings:
   1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.

G. Belt Drives:
   1. Factory mounted, with adjustable alignment and belt tensioning.
   2. Service Factor Based on Fan Motor Size: 1.5.
   3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
   4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
   5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
   6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

H. Accessories:
   2. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.
   3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
   4. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
   5. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
   6. Inlet Screens: Grid screen of same material as housing.
7. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.

2.3 FORWARD-CURVED CENTRIFUGAL FANS

A. Greenheck, Cook, Penn

B. Description:
   1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
   2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
   3. Factory-installed and -wired disconnect switch.

C. Housings:
   1. Formed panels to make curved-scroll housings with shaped cutoff.
   2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
   3. Horizontally split, bolted-flange housing.
   4. Spun inlet cone with flange.
   5. Outlet flange.

D. Forward-Curved Wheels:
   1. Black-enamedeled or galvanized-steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow.
   2. Mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.

E. Shafts:
   1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
   2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
   3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Grease-Lubricated Shaft Bearings:
   1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
G. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: 1.5.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

H. Accessories:

2. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
5. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
6. Inlet Screens: Grid screen of same material as housing.
7. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.

2.4 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install centrifugal fans level and plumb.
B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting:

1. Install centrifugal fans on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations.
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Curb Support: Install roof curb on roof structure, level and secure, according to "The NRCA Roofing and Waterproofing Manual," Low-Slope Membrane Roofing Construction Details Section, Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install and secure centrifugal fans on curbs, and coordinate roof penetrations and flashing with roof construction. Secure units to curb support with anchor bolts.

F. Unit Support: Install centrifugal fans level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure units to structural support with anchor bolts.

G. Isolation Curb Support: Install centrifugal fans on isolation curbs, and install flexible duct connectors and vibration isolation and seismic-control devices.

1. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.
2. Comply with requirements in Section 230548.13 "Vibration Controls for HVAC" for vibration isolation devices.

H. Install units with clearances for service and maintenance.

I. Label fans according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to fans to allow service and maintenance.

C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.
3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. See Section 230593 "Testing, Adjusting, and Balancing For HVAC" for testing, adjusting, and balancing procedures.
10. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 23 34 16
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Bypass, single-duct air terminal units.
   2. Shutoff, single-duct air terminal units.
   3. Casing liner.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of air terminal unit.

B. LEED Submittals:
   1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 – “Systems and Equipment.”
   2. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.

C. Shop Drawings: For air terminal units.
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.
   4. Hangers and supports, including methods for duct and building attachment and vibration isolation.

D. Delegated-Design Submittal:
   1. Materials, fabrication, assembly, and spacing of hangers and supports.
   2. Include design calculations, including analysis data for selecting hangers and supports.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

B. Field quality-control reports.
1.4 CLOSEOUT SUBMITTALS
   A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by
      a qualified testing agency, and marked for intended location and application.
   
   B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and
      Equipment" and Section 7 - "Construction and System Start-up."
   
   C. ASHRAE Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating,
      Ventilating, and Air Conditioning."

2.2 BYPASS, SINGLE-DUCT AIR TERMINAL UNITS
   A. Titus, Price, Krueger
   
   B. Configuration: Diverting-damper assembly inside unit casing with control components inside a
      protective metal shroud.
   
   C. Casing: 0.034-inch- (0.85-mm-) thick galvanized steel, single wall.
      1. Casing Liner: Comply with requirements in "Casing Liner" Article for flexible
         elastomeric duct liner.
   
   D. Diverter Assembly: Galvanized-steel gate, with polyethylene linear bearings.
   
   E. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no
      closer than 0.1 inch (2.5 mm), and rated for a minimum working pressure of 200 psig (1380
      kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air
      vent and drain valve.
   
   F. Electric Controls: Damper actuator and thermostat.
      1. Damper Actuator: 24 V, powered closed, powered open.
      2. Thermostat: Wall-mounted electric type with temperature display in Fahrenheit and
         Celsius, and space temperature set point.
      3. Changeover Thermostat: Duct-mounted, field-adjustable, electric type reverses action of
         zone thermostat when air temperature reaches 70 deg F (21 deg C).
   
   G. Electronic Controls: Bidirectional damper operator and microprocessor-based thermostat.
      Control devices shall be compatible with temperature controls specified in Section 230923
      "Direct Digital Control (DDC) System for HVAC" and shall have the following features:
1. Damper Actuator: 24 V, powered open, spring return.
2. Thermostat: Wall-mounted electronic type with the following features:
   a. Temperature set-point display in Fahrenheit and Celsius.
   b. Auxiliary switch to energize heating control circuit.
   c. Changeover thermistor to reverse action.

H. Direct Digital Controls: Single-package unitary controller and actuator specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

2.3 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

A. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

B. Casing: 0.034-inch- (0.85-mm-) thick galvanized steel, single wall.
   2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
   3. Air Outlet: S-slip and drive connections, size matching inlet size.
   4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
   5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from zero to 140 deg F (minus 18 to plus 60 deg C), shall be impervious to moisture and fungus, shall be suitable for 10-inch wg (2500-Pa) static pressure, and shall be factory tested for leaks.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
   1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg (750-Pa) inlet static pressure.

E. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), and rated for a minimum working pressure of 200 psig (1380 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve.

F. Control devices shall be compatible with temperature controls system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
   1. Electric Damper Actuator: 24 V, powered open, spring return.
   2. Electronic Damper Actuator: 24 V, powered open, spring return.
   3. Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.

5. Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg (1000 Pa); and shall have a multipoint velocity sensor at air inlet.

6. Terminal Unit Controller: Pressure-independent, variable-air-volume (VAV) controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
   a. Occupied and unoccupied operating mode.
   b. Remote reset of airflow or temperature set points.
   c. Adjusting and monitoring with portable terminal.
   d. Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

7. Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.

G. Controls:
   1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg (60- and 750-Pa) inlet static pressure.
   2. System-powered, wall-mounted thermostat.

H. Control Sequences:
   1. Occupied:
      a. In a call for cooling, airflow will increase as the damper opens towards maximum setting to satisfy set point.
      b. In a call for less cooling, airflow will decrease as the damper closes towards minimum setting to satisfy set point.
   2. Unoccupied:
      a. Damper closes to minimum maximum setting.

2.4 CASING LINER

A. Casing Liner: Fibrous-glass duct liner, complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

   1. Minimum Thickness: 3/4 inch (19 mm).
      a. Maximum Thermal Conductivity:
         1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F (0.033 W/m x K) at 75 deg F (24 deg C) mean temperature.

2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

3. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
   a. Adhesive VOC Content: 80 g/L or less.
   b. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Casing Liner: Flexible elastomeric duct liner fabricated of preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
   1. Minimum Thickness: 3/4 inch (19 mm).
   2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
   3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
      a. Adhesive VOC Content: 50 g/L or less.
      b. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.5 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to AHRI 880.
   1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and AHRI certification seal.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches (100 mm) thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches (100 mm) thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.2 TERMINAL UNIT INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install wall-mounted thermostats.

D. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.

E. Hot-Water Piping: Comply with requirements in Section 232113 "Hydronic Piping" and connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

F. Comply with requirements in Section 233113 "Metal Ducts" for connecting ducts to air terminal units.

G. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

H. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Air terminal unit will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 23 36 00
SECTION 23 37 13.13 - AIR DIFFUSERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Round ceiling diffusers.
2. Rectangular and square ceiling diffusers.
3. Louver face diffusers.

B. Related Requirements:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ROUND CEILING DIFFUSERS

A. Devices shall be specifically designed for variable-air-volume flows.

B. Material: Steel.

C. Finish: Baked enamel, color selected by Architect.

D. Face Style: Four cone.

E. Mounting: Duct connection.

F. Pattern: Two-position horizontal.

G. Dampers: Radial opposed blade.

H. Accessories:

1. Equalizing grid.
2. Plaster ring.
4. Wire guard.
5. Sectorizing baffles.
6. Operating rod extension.

2.2 RECTANGULAR AND SQUARE CEILING DIFFUSERS

A. Devices shall be specifically designed for variable-air-volume flows.
B. Material: Steel.
C. Finish: Baked enamel, white.
D. Face Size: 24 by 24 inches (600 by 600 mm).
E. Face Style: Plaque.
F. Mounting: Surface and lay-in.
G. Pattern: Fixed.
H. Dampers: Radial opposed blade.
I. Accessories:
   1. Equalizing grid.
   2. Plaster ring.
   4. Wire guard.
   5. Sectorizing baffles.
   6. Operating rod extension.

2.3 LOUVER FACE DIFFUSERS

A. Devices shall be specifically designed for variable-air-volume flows.
B. Material: Steel.
C. Finish: Baked enamel, color selected by Architect.
D. Mounting: Surface.
E. Pattern: Adjustable core style.
F. Dampers: Radial opposed blade.
G. Accessories:
   1. Square to round neck adaptor.
   2. Adjustable pattern vanes.
   3. Throw reducing vanes.
   4. Equalizing grid.
5. Plaster ring.
7. Wire guard.
8. Sectorizing baffles.
9. Operating rod extension.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install diffusers level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13.13
SECTION 23 52 16 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes gas-fired, fire-tube condensing boilers, trim, and accessories for generating hot water.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

B. Delegated-Design Submittal: For each boiler.
   1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.
      a. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
      b. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.3 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.
1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Fire-Tube Condensing Boilers:
   a. Leakage and Materials: 10 years from date of Substantial Completion.
   b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Nonprorated for five years from date of Substantial Completion.

2. Warranty Period for Water-Tube Condensing Boilers: 20 years from date of Substantial Completion.

3. Warranty Period for Water-Jacketed Condensing Boilers:
   a. Leakage and Materials: Eight years from date of Substantial Completion.
   b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Nonprorated for five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label boilers to comply with 2010 ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N.

E. UL Compliance: Test boilers for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

F. CSA Compliance: Test boilers for compliance with CSA B51.

G. Mounting Base: For securing boiler to concrete base.
   1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when mounting base is anchored to building structure.
2.2 FORCED-DRAFT, FIRE-TUBE CONDENSING BOILERS

A. Manufacturers:
   1. Lochinvar.
   2. AERCO.
   3. Thermal Solutions.
   4. RBI

B. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water-heating service only.

C. Heat Exchanger: Nonferrous, corrosion-resistant combustion chamber.

D. Pressure Vessel: Carbon steel with welded heads and tube connections.

E. Burner: Natural gas, forced draft.

F. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
   1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
      a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

G. Gas Train: Combination gas valve with manual shutoff and pressure regulator.

H. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

I. Casing:
   1. Jacket: Sheet metal, with snap-in or interlocking closures.
   2. Control Compartment Enclosures: NEMA 250, Type 1A.
   4. Insulation: Minimum 2-inch- (50-mm-) thick, mineral-fiber or polyurethane-foam insulation surrounding the heat exchanger.

J. Capacities and Characteristics:
   2. See schedule on drawings.
2.3 TRIM

A. Include devices sized to comply with ASME B31.9.

B. Aquastat Controllers: Operating, firing rate, and high limit.

C. Safety Relief Valve: ASME rated.

D. Pressure and Temperature Gage: Minimum 3-1/2-inch- (89-mm-) diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.

E. Boiler Air Vent: Automatic.


G. Circulation Pump: Nonoverloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

2.4 CONTROLS

A. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

B. Boiler operating controls shall include the following devices and features:

1. Control transformer.
2. Set-Point Adjust: Set points shall be adjustable.
3. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.
   a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

C. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Cutoff: Automatic reset stops burner if operating conditions rise above maximum boiler design temperature.
2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be automatic-reset type.
4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
D. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.

1. Hardwired Points:
   b. Control: On/off operation, hot-water-supply temperature set-point adjustment.

2. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

2.5 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

1. House in NEMA 250, Type 1 enclosure.
2. Wiring shall be numbered and color coded to match wiring diagram.
3. Install factory wiring outside of an enclosure in a metal raceway.
4. Field power interface shall be to circuit breaker.
5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
6. Provide each motor with overcurrent protection.

2.6 VENTING KITS

A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.

B. Combustion-Air Intake: Complete system, PVC, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

2.7 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers, before shipping, according to 2010 ASME Boiler and Pressure Vessel Code.
PART 3 - EXECUTION

3.1 BOILER INSTALLATION

A. Equipment Mounting:
   1. Install boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations.
   2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Install gas-fired boilers according to NFPA 54.

C. Assemble and install boiler trim.

D. Install electrical devices furnished with boiler but not specified to be factory mounted.

E. Install control wiring to field-mounted electrical devices.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 232116 "Hydronic Piping Specialties."

E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required.

F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

G. Install piping from safety relief valves to nearest floor drain.

H. Boiler Venting:
   1. Install flue venting kit and combustion-air intake.
   2. Connect full size to boiler connections.

I. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
J. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
   b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

B. Boiler will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain boilers.
SECTION 23 74 16.13 - PACKAGED, LARGE-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes packaged, large-capacity, rooftop air conditioning units (RTUs) with the following components and accessories:

1. Casings.
2. Fans.
3. Motors.
5. Refrigerant circuit components.
6. Air filtration.
7. Electric coils.
8. Dampers.
9. Electrical power connections.
10. Controls.
11. Accessories
12. Roof curbs.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
1.3 INFORMATIONAL SUBMITTALS
   A. Coordination Drawings: Plans and other details, drawn to scale and coordinated with each other, using input from installers of the items involved.
   B. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article.
   C. Field quality-control reports.
   D. Sample warranty.

1.4 CLOSEOUT SUBMITTALS
   A. Operation and maintenance data.

1.5 WARRANTY
   A. Special Warranty: Manufacturer agrees to repair or replace components of RTUs that fail in materials or workmanship within specified warranty period.
      1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
      2. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
      3. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION
   A. AHRI Compliance:
      1. Comply with AHRI 340/360 for testing and rating energy efficiencies for RTUs.
      2. Comply with AHRI 270 for testing and rating sound performance for RTUs.
      3. Comply with AHRI 1060 for testing and rating performance for air-to-air exchanger.
      4. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs.
   B. AMCA Compliance:
      1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
      2. Damper leakage tested in accordance with AMCA 500-D.
      3. Operating Limits: Classify according to AMCA 99.
   C. ASHRAE Compliance:
1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. NFPA Compliance: Comply with NFPA 90A or NFPA 90B.


G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AAON.
2. Carrier Corporation; a unit of United Technologies Corp.
4. Trane.

2.3 CAPACITIES AND CHARACTERISTICS

A. Refer to equipment schedule on drawings for performance requirements.

2.4 CASINGS

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Double-Wall Construction: Fill space between walls with 2 inch (50 mm) foam insulation and seal moisture tight for R-13 performance.

C. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

D. Inner Casing Fabrication Requirements:

1. Inside Casing: G-90-coated galvanized steel, 0.034 inch (0.86 mm) thick, perforated 40 percent free area.

E. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
1. Materials: ASTM C 1071, Type I.
2. Thickness: 1 inch (25 mm).
3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
4. Liner Adhesive: Comply with ASTM C 916, Type I.

F. Plastic Condensate Drain Pans: Fabricated using rigid heavy plastic polymer complying with ASTM G21, a minimum of 2 inches (50 mm) deep, and complying with ASHRAE 62.1 for design and construction of drain pans.

G. Condensate Drain Pans: Fabricated using stainless 0.025 inches (0.715 mm) thick steel sheet, a minimum of 2 inches (50 mm) deep, and complying with ASHRAE 62.1 for design and construction of drain pans.

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
2. Drain Connections: Threaded nipple.

H. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.5 FANS

A. Supply-Air Fans: Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

1. Direct-Driven Supply-Air Fans: Motor shall be resiliently mounted in the fan inlet.
2. Belt-Driven Supply-Air Fans: Motors shall be installed on an adjustable fan base resiliently mounted in the casing.

B. Condenser-Coil Fan: Variable-speed propeller, mounted on shaft of permanently lubricated ECM motors.

2.6 MOTORS

A. Comply with Section 230513 "Common Motor Requirements for HVAC Equipment" and the requirements of this Article.

B. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.7 COILS

A. Supply-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.

B. Outdoor-Air Refrigerant Coil:
1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.

C. Electric-Resistance Heating:
1. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
2. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box.
3. Overcurrent Protection: Manual-reset thermal cutouts, factory wired in each heater stage.
4. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:
   a. Magnetic contactors.
   b. Step Controller: Pilot lights and override toggle switch for each step.
   c. SCR Controller: Pilot lights operate on load ratio, a minimum of five steps.
   d. Time-delay relay.
   e. Airflow proving switch.

2.8 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits: Two.

B. Compressor: Hermetic, variable speed scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.

C. Refrigeration Specialties:
1. Refrigerant: R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
5. Automatic-reset low-pressure safety switch.
8. Brass service valves installed in compressor suction and liquid lines.
2.9 AIR FILTRATION

A. Minimum arrestance and a minimum efficiency reporting value according to ASHRAE 52.2.

B. Flat Panel Filters:

1. Description: Factory-fabricated, self-supported, flat, nonpleated, panel-type, disposable air filters with holding frames.
2. Filter Unit Class: UL 900, Class 1.
   a. Adhesive: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.
   b. Adhesive: As recommended by air-filter manufacturer and that complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
   c. Media shall be coated with an antimicrobial agent.
   d. Metal Retainer: Upstream side and downstream side.

C. Pleated Panel Filters:

1. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.
2. Filter Unit Class: UL 900, Class 1.
   a. Adhesive: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.
   b. Adhesive: As recommended by air-filter manufacturer and that complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
   c. Media shall be coated with an antimicrobial agent.
   d. Separators shall be bonded to the media to maintain pleat configuration.
   e. Welded-wire grid shall be on downstream side to maintain pleat.
   f. Media shall be bonded to frame to prevent air bypass.
   g. Support members on upstream and downstream sides to maintain pleat spacing.

2.10 DAMPERS

A. Outdoor-Air Damper: Linked damper blades with motorized damper filter.

B. Outdoor- and Return-Air Mixing Dampers: Opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect so dampers operate simultaneously.

1. Leakage Rate: As required by ASHRAE/IES 90.1.
2. Damper Motor: Modulating with adjustable minimum position.

2.11 ELECTRICAL POWER CONNECTIONS

A. RTU shall have a single connection of power to unit with control-circuit transformer with built-in overcurrent protection.

2.12 CONTROLS

A. Basic Unit Controls:

1. Control-voltage transformer.
2. Wall-mounted thermostat or sensor with the following features:
   b. Fan on-auto switch.
   c. Fan-speed switch.
   d. Automatic changeover.
   e. Adjustable deadband.
   f. Exposed set point.
   g. Temperature indication.
   h. Degree F indication.
   i. Unoccupied-period-override push button.
   j. Data entry and access port to input temperature set points, occupied and unoccupied periods, and output room temperature, supply-air temperature, operating mode, and status.

3. Unit-Mounted Annunciator Panel for Each Unit:
   a. Lights to indicate power on, cooling, heating, fan running, filter dirty, and unit alarm or failure.
   b. DDC controller or programmable timer and interface with HVAC instrumentation and control system.
   c. Digital display of outdoor-air temperature, supply-air temperature, return-air temperature, economizer damper position, indoor-air quality, and control parameters.

B. DDC Controller:

1. Controller shall have non-volatile-memory backup.
2. Safety Control Operation:
   a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
   b. Firestats: Stop fan and close outdoor-air damper if air greater than 130 deg F (54 deg C) enters unit. Provide additional contacts for alarm interface to fire alarm control panel.
3. Scheduled Operation: Occupied and unoccupied periods on 365-day clock with a minimum of four programmable periods per day.

4. Terminal-Unit Relays:
   a. Provide heating- and cooling-mode changeover relays compatible with terminal control system.

C. Interface Requirements for HVAC Instrumentation and Control System:
   1. Interface relay for scheduled operation.
   2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
   3. Provide compatible interface for central campus HVAC control workstation.

2.13 ACCESSORIES

A. Electric heater with integral thermostat maintains minimum 50 deg F (10 deg C) temperature.

B. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required.

C. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

D. Remote potentiometer to adjust minimum economizer damper position.

E. Return-air bypass damper.

F. Factory- or field-installed demand-controlled ventilation.

G. Safeties:
   1. Smoke detector.
   2. Condensate overflow switch.
   3. Phase-loss reversal protection.
   4. High and low pressure control.
   5. Electric coil airflow-proving switch.

H. Coil guards of painted, galvanized-steel wire.

I. Hail guards of galvanized steel, painted to match casing.

J. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.

K. Door switches to disable heating or reset set point when open.

L. Outdoor air intake weather hood.
2.14 ROOF CURBS

A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
   a. Materials: ASTM C 1071, Type I or II.
   b. Thickness: 2 inches (50 mm).

2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
   a. Liner Adhesive: Comply with ASTM C 916, Type I.
   b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
   c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
   d. Liner Adhesive: Comply with ASTM C 916, Type I.

B. Curb Dimensions: Height of 14 inches. Adaptable dimensions as required for roof openings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Roof Curb: Install on roof structure, level and secure, according to NRCA's "NRCA Roofing Manual: Membrane Roof Systems." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction. Secure RTUs to upper curb rail, and secure curb base to roof framing.

B. Unit Support: Install unit level on structural curbs. Secure RTUs to structural support with anchor bolts.

C. Equipment Mounting:
   1. Comply with requirements for vibration isolation devices.

3.2 CONNECTIONS

A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

B. Install piping adjacent to RTUs to allow service and maintenance.
C. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to RTUs with flexible duct connectors.
4. Install return-air duct continuously through roof structure.
5. Install normal-weight, 3000-psi (20.7-MPa), compressive strength (28-day) concrete mix inside roof curb, 4 inches (100 mm) thick. Concrete, formwork, and reinforcement are specified with concrete.

D. Connect electrical wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs as layers of black with engraved white letters at least 1/2-inch (13-mm) high.
2. Locate nameplate where easily visible.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. RTU will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.
3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs.

END OF SECTION 23 74 16.13
SECTION 23 81 26 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.

2. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 – “Systems and Equipment.”

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.3 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:
   a. For Compressor: Five year(s) from date of Substantial Completion.
   b. For Parts: One year from date of Substantial Completion.
   c. For Labor: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Mitsubishi, Sanyo, Daikin or LG

2.2 INDOOR UNITS (5 TONS OR LESS)

A. Wall-Mounted, Evaporator-Fan Components:

   1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
   2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
   3. Fan: Direct drive, centrifugal.
   4. Fan Motors:

      a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
      b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
      c. Enclosure Type: Totally enclosed, fan cooled.
      d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
      e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

6. Condensate Drain Pans:
   a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
      1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
      2) Depth: A minimum of 1 inch deep.
   c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
   d. Pan-Top Surface Coating: Asphaltic waterproofing compound.

7. Air Filtration Section:
   a. General Requirements for Air Filtration Section:
      1) Comply with NFPA 90A.
      2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
      3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:
   1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
   2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
      a. Compressor Type: Scroll.
      b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
      c. Refrigerant Charge: R-410.
      d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
   4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 0 deg F.

2.4 ACCESSORIES

A. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
   1. Compressor time delay.
   2. 24-hour time control of system stop and start.
   3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
   4. Fan-speed selection including auto setting.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

D. Drain Hose: For condensate.

E. Additional Monitoring:
   1. Monitor constant and variable motor loads.
   3. Monitor cooling load.
   4. Monitor air distribution static pressure and ventilation air volumes.

2.5 CAPACITIES AND CHARACTERISTICS

A. Refer to equipment schedule on drawings for performance requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Equipment Mounting:
   1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s).
2. Install ground-mounted, compressor-condenser components on polyethylene mounting base.

D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.3 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 81 26
SECTION 23 82 39.19 - ELECTRIC UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes wall and suspended heaters with propeller fans and electric-resistance heating coils.

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product.
      1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
   B. Shop Drawings:
      1. Include plans, elevations, sections, and details.
      2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      3. Include details of anchorages and attachments to structure and to supported equipment.
      4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
   C. Samples: For each exposed product and for each color and texture specified.

1.3 CLOSEOUT SUBMITTALS
   A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Raywall, Q-Mark or Brasch

2.2 DESCRIPTION
   A. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 CABINET

A. Wall mounted
   1. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.
   2. Finish: Baked enamel over baked-on primer or powder coated with manufacturer's standard color.
   3. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.
   4. Provide with recessed mounting wall box for wall mounted units.

B. Suspended
   1. Welded steel construction
   2. Finish: Baked enamel over baked-on primer or powder coated with manufacturer's standard color.

2.4 COIL


2.5 FAN AND MOTOR

A. Fan: Aluminum propeller directly connected to motor.

B. Motor: Permanently lubricated. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.6 CONTROLS

A. Controls: Unit-mounted thermostat.

B. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

2.7 CAPACITIES AND CHARACTERISTICS

1. Refer to equipment schedule on drawings for performance requirements.
3.1 INSTALLATION

A. Install wall and ceiling unit heaters to comply with NFPA 90A.

B. Install wall and ceiling unit heaters level and plumb.

C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 23 82 39.19
SECTION 26 05 19 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid:
   1. Electrical Contractor shall provide building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

B. Alternate Bid:
   1. None.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
   1. All Division 26 sections.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field Quality-Control Test Reports: From Contractor.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70 and all appendices.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 CONDUCTORS AND CABLES

A. Manufacturers:

1. Alcan Aluminum Corporation; Alcan Cable Div.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

C. Conductor Material: Copper complying with NEMA WC 5 solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.

D. Conductor Insulation Types: Type THHN-THWN complying with NEMA WC 5.

2.3 CONNECTORS AND SPLICES

A. Manufacturers:

1. AFC Cable Systems, Inc.
2. AMP Incorporated/Tyco International.
3. Hubbell/Anderson.
4. O-Z/Gedney; EGS Electrical Group LLC.
5. 3M Company; Electrical Products Division.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: Type THHN-THWN, single conductors in raceway.
E. Exposed Branch Circuits, including in Crawlspace: Type THHN-THWN, single conductors in raceway.
F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
G. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.
H. Underground Feeders and Branch Circuits: Type THHN-THWN, single conductors in raceway.
I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord.
J. Fire Alarm Circuits: See Section 28 31 11 for installation requirements.
K. Class 1 Control Circuits: Type THHN-THWN, in raceway.

3.2 INSTALLATION
A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
E. Support cables according to Division 26 Section "Basic Electrical Materials and Methods."
F. Seal around cables penetrating fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."
G. Identify and color-code conductors and cables according to Division 26 Section "Electrical Identification."
H. Provide a ground conductor in all feeder and branch circuits.

3.3 CONNECTIONS
A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
   1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:
   1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
   2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.

B. Test Reports: Prepare a written report to record the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

END OF SECTION 26 05 19
PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid:

   1. Electrical Contractor shall provide grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other Section of these Specifications.

B. Alternate Bid:

   1. None.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections: The following Sections contain requirements that relate to this Section:

   1. See Section 26 05 19 “Conductors and Cables” for additional requirements for grounding conductors.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Data: For the following:

   1. Ground rods.

C. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

D. Field Test Reports: Submit written test reports to include the following:

   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1. Comply with UL 467.

C. Comply with NFPA 70 and all appendices; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.

D. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Grounding Conductors, Cables, Connectors, and Rods:
   a. Apache Grounding/Erico Inc.
   b. Boggs, Inc.
   c. Chance/Hubbell.
   d. Copperweld Corp.
   e. Dossert Corp.
   g. Framatome Connectors/Burndy Electrical.
   h. Galvan Industries, Inc.
   i. Harger Lightning Protection, Inc.
   j. Hastings Fiber Glass Products, Inc.
   k. Heary Brothers Lightning Protection Co.
   l. Ideal Industries, Inc.
   m. ILSCO.
   o. Korns: C. C. Korns Co.; Division of Robroy Industries.
   p. Lightning Master Corp.
   q. Lyncole XIT Grounding.
   r. O-Z/Gedney Co.; a business of the EGS Electrical Group.
   s. Raco, Inc.; Division of Hubbell.
   t. Robbins Lightning, Inc.
   v. Superior Grounding Systems, Inc.
2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Section 26 05 19 "Conductors and Cables."

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.

E. Grounding Electrode Conductors: Stranded cable, size as indicated on drawings.

F. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

G. Bare Copper Conductors: Comply with the following:

H. Copper Bonding Conductors: As follows:
   1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch (6.4 mm) in diameter.
   2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
   3. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.

I. Ground Conductor and Conductor Protector for Wood Poles: As follows:
   1. No. 4 AWG minimum, soft-drawn copper conductor.
   2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir, or cypress or cedar.

J. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators. Size as indicated on drawings.

2.3 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors. Compression type may be used on ground bus only.
C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel.

B. Ground Rods: Sectional type; copper-clad steel.
   1. Size: 3/4 by 120 inches (19 by 3000 mm) in diameter and length.

PART 3 - EXECUTION

3.1 APPLICATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections.

D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

E. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Use insulated spacer; space 1 inch (25.4 mm) from wall and support from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install equipment grounding conductors in all feeders and circuits.

C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:
   1. Feeders and branch circuits.
   2. Lighting circuits.
   3. Receptacle circuits.
   5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.

D. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

E. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.

F. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

G. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment grounding conductor. Isolate equipment grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

H. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

I. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.

J. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

K. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

   2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

L. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

M. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
N. Fence Grounding: Bond all gates to fence posts with braided bond wire. Provide ground rods at all face corners, gates and every 150 feet on center along fence length. Bond fence fabric to posts containing ground rods and for each independent section of fence fabric.

3.3 COUNTERPOISE

A. Ground the steel framework of the building with a driven ground rod at the base of every corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart. Provide a grounding conductor (counterpoise), electrically connected to each ground rod and to each steel column, extending around the perimeter of the building. Use tinned-copper conductor not less than No. 2/0 AWG for counterpoise and for tap to building steel. Bury counterpoise not less than 18 inches (450 mm) below grade and 24 inches (600 mm) from building foundation.

3.4 INSTALLATION

A. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.

1. Drive ground rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

D. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

E. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

F. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.
G. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

3.5 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

F. Compression-Type Connections (where indicated in this section): Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.6 OVERHEAD-LINE GROUNDING

A. Comply with IEEE C2 requirements. Use 2 or more parallel ground rods if a single ground rod electrode resistance to ground exceeds 25 ohms.

B. Drive ground rods to a depth of 12 inches (300 mm) below finished grade in undisturbed earth.
C. Ground Rod Connections: Use clamp-type connectors listed for the purpose for underground connections and connections to rods.

D. Lightning Arresters: Separate arrester grounds from other grounding conductors.

E. Secondary Neutral and Tank of Transformer: Interconnect and connect to grounding conductor.

F. Protect grounding conductors running on surface of wood poles with molding extended from grade level up to and through communication service and transformer spaces.

3.7 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

B. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

C. Pad-Mounted Transformers and Switches: Install two ground rods. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than No. 2 AWG for taps to equipment ground pad.

3.8 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.

3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and
include observations of weather and other phenomena that may affect test results.
Describe measures taken to improve test results.

a. Equipment Rated 500 kVA and Less: 10 ohms.
b. Equipment Rated 500 to 1000 kVA: 5 ohms.
c. Equipment Rated More Than 1000 kVA: 3 ohms.
e. Manhole Grounds: 10 ohms.

4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.9 GRADING AND PLANTING

A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 2 Section "Landscaping." Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION 26 05 26
SECTION 26 05 29 - ELECTRICAL SUPPORTS AND SEISMIC RESTRAINTS

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid:
   1. Electrical Contractor shall provide seismic restraint for panelboards, light fixtures, conduit over 2” in diameter, and other equipment mentioned in Paragraph 3.4.B.

B. Alternate Bid:
   1. None.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Seismic restraints for electrical equipment and systems.
   3. Construction requirements for concrete bases.

1.4 DEFINITIONS

A. EMT: Electrical metallic tubing.


C. IMC: Intermediate metal conduit.


E. OSHPD: Office of Statewide Health Planning and Development.

F. RMC: Rigid metal conduit.


H. Seismic Restraint: A structural support element such as a metal framing member, a cable, an anchor bolt or stud, a fastening device, or an assembly of these items used to transmit seismic
forces from an item of equipment or system to building structure and to limit movement of item during a seismic event.


1.5 SUBMITTALS

A. Product Data: Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of electrical support and seismic-restraint component used.

1. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
2. Annotate to indicate application of each product submitted and compliance with requirements.

B. Shop Drawings: Indicate materials and dimensions and identify hardware, including attachment and anchorage devices, signed and sealed by a qualified professional engineer. Professional engineer qualification requirements are specified in Division 1 Section "Quality Requirements." Include the following:

1. Fabricated Supports: Representations of field-fabricated supports not detailed on Drawings.
2. Seismic Restraints: Detail anchorage and bracing not defined by details or charts on Drawings. Include the following:
   a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
   b. Details: Detail fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
   c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

C. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.

D. Welding certificates.

E. Qualification Data: For professional engineer and testing agency.

F. Field quality-control test reports.

1.6 QUALITY ASSURANCE
A. Comply with seismic-restraint requirements in the BOCA unless requirements in this Section are more stringent.

B. Testing of Seismic Anchorage Devices: Comply with testing requirements in Part 3 and in Division 26 Section "Basic Electrical Materials and Methods."

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 PROJECT CONDITIONS
A. Acceleration Factor as Defined in BOCA: .15.
B. Project Seismic Hazard Exposure Group as Defined in BOCA: II.

1.8 COORDINATION
A. Coordinate layout and installation of seismic bracing with building structural system and architectural features, and with mechanical, fire-protection, electrical, and other building features in the vicinity.
B. Coordinate concrete bases with building structural system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS
A. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed under this Project, with a minimum structural safety factor of five times the applied force.
B. Steel Slotted Support Systems: Comply with MFMA-3, factory-fabricated components for field assembly.
   1. Manufacturers:
      a. Cooper B-Line; a division of Cooper Industries.
      b. ERICO International Corporation.
c. Allied Support Systems; Power-Strut Unit.

d. GS Metals Corp.

e. Michigan Hanger Co., Inc.; O-Strut Div.

f. National Pipe Hanger Corp.

g. Thomas & Betts Corporation.

h. Unistrut; Tyco International, Ltd.

i. Wesanco, Inc.

2. Finishes:

a. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-3.

b. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-3.

c. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-3.

3. Channel Dimensions: Selected for structural loading and applicable seismic forces.

C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.

1. Manufacturers:

a. Allied Support Systems; Aickinstrut Unit.

b. Cooper B-Line; a division of Cooper Industries.

c. Fabco Plastics Wholesale Limited.

d. Seasafe, Inc.

2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.

3. Fitting and Accessory Materials: Same as channels and angles.

4. Rated Strength: Selected to suit structural loading and applicable seismic forces.

D. Raceway and Cable Supports: As described in NECA 1.

E. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

F. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

G. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

H. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Manufacturers:
      1) Hilti, Inc.
      2) ITW Construction Products.
      3) MKT Fastening, LLC.
      4) Simpson Strong-Tie Co. Inc.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Manufacturers:
      1) Cooper B-Line; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc
      3) Hilti, Inc.
      4) ITW Construction Products.
      5) MKT Fastening, LLC.
      6) Powers Fasteners.

3. Concrete Inserts: Steel or malleable-iron slotted-support-system units similar to MSS Type 18; complying with MFMA-3 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.


2.3 SEISMIC-RESTRAINT COMPONENTS

A. Rated Strength, Features, and Application Requirements for Restraint Components: As defined in reports by an agency acceptable to authorities having jurisdiction.
   1. Structural Safety Factor: Strength in tension, shear, and pullout force of components used shall be at least five times the maximum seismic forces to which they will be subjected.

B. Angle and Channel-Type Brace Assemblies: Steel angles or steel slotted-support-system components; with accessories for attachment to braced component at one end and to building structure at the other end.

C. Cable Restraints: ASTM A 603, zinc-coated, steel wire rope attached to steel or stainless-steel thimbles, brackets, swivels, and bolts designed for restraining cable service.
   1. Manufacturers:
2. Seismic Mountings, Anchors, and Attachments: Devices as specified in Part 2 "Support, Anchorage, and Attachment Components" Article, selected to resist seismic forces.

3. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod, of design recognized by an agency acceptable to authorities having jurisdiction.

4. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to type and size of anchor bolts and studs used.

5. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to type and size of attachment devices used.

2.4 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 5 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 for application of hangers and supports for electrical equipment and systems, except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

2. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.
3.2 SUPPORT AND SEISMIC-RESTRAINT INSTALLATION

A. Comply with NECA 1 for installation requirements, except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Install seismic-restraint components using methods approved by the evaluation service providing required submittals for component.

D. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

E. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

F. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

G. See Section 26 51 19 for light fixture anchoring requirements.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 5 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.
3.4 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and seismic criteria at Project.

B. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so expansion anchors will be a minimum of 10 bolt diameters from edge of the base.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of the base.
2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
6. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 Section "Cast-in-Place Concrete."

3.5 INSTALLATION OF SEISMIC-RESTRAINT COMPONENTS

A. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

C. Restraint Cables: Provide slack within maximums recommended by manufacturer.

D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, upper truss chords of bar joists, or at concrete members.

3.6 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Make flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross expansion and seismic-control joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to electrical equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.7 FIELD QUALITY CONTROL

A. Testing: Test pullout resistance of seismic anchorage devices.
1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.


4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.

5. Test to 90 percent of rated proof load of device.

6. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

B. Record test results.

END OF SECTION 26 05 29
SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.
C. Delegated-Design Submittal: For hangers and supports for electrical systems.
   1. Include design calculations and details of trapeze hangers.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, and coordinated with each other, using input from installers of the items involved:
B. Seismic Qualification Certificates: For hangers and supports for electrical equipment and systems, accessories, and components, from manufacturer.
C. Welding certificates.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.
B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
2. Component Importance Factor: 1.5.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4 factory-fabricated components for field assembly.
   1. Material: Stainless Steel, Grade 304.
   2. Channel Width: 1-5/8 inches (41.25 mm).
   3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
   5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
   7. Channel Dimensions: Selected for applicable load criteria.

B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
   4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
   5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
   6. Toggle Bolts: All-steel springhead type.
2.3  Fabri cated Metal Equipment Support Assemblies

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

Part 3 - Execution

3.1  Application

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems unless requirements in this Section are stricter.

B. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

E. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2  Support Installation

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.
3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

A. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29
PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Electrical contractor shall provide raceways, fittings, boxes, enclosures, and cabinets for electrical wiring and circuitry associated with this project.

   a. Raceways include the following:

      1) RMC.
      2) IMC.
      3) EMT.
      4) FMC.
      5) LFMC.
      6) RNC.
      7) Wireways.
      8) Surface raceways.

   b. Boxes, enclosures and cabinets include the following:

      1) Device boxes.
      2) Outlet boxes.
      3) Pull and junction boxes.
      4) Cabinets and hinged-cover enclosures.
      5) Floor boxes.

B. Alternate Bid:

1. None.

1.2 RELATED DOCUMENTS

A. Related Sections include the following:

1. Division 7 Section “Firestopping.”
2. Division 26 Section “Basic Electrical Materials and Methods” for raceways and box supports.
3. Division 26 Section “Wiring Devices” for devices installed in boxes and for floor-box service fittings.

B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. FMC: Flexible metal conduit.
C. IMC: Intermediate metal conduit.
D. LFMC: Liquidtight flexible metal conduit.
E. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:
   1. Ceiling suspension assembly members.
   2. Method of attaching hangers to building structure.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

C. Manufacturer Seismic Qualification Certification: Submit certification that enclosures, cabinets, accessories, and components will withstand seismic forces defined in Division 16 Section "Seismic Controls for Electrical Work." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with NFPA 70 and all appendices.

1.6 COORDINATION
A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 METAL CONDUIT AND TUBING
A. Manufacturers:
   1. AFC Cable Systems, Inc.
   2. Alflex Inc.
   3. Anamet Electrical, Inc.; Anaconda Metal Hose.
   4. Electri-Flex Co.
   5. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
   6. LTV Steel Tubular Products Company.
   7. Manhattan/CDT/Cole-Flex.
   8. O-Z Gedney; Unit of General Signal.
   9. Wheatland Tube Co.
B. Rigid Steel Conduit: ANSI C80.1.
C. Aluminum Rigid Conduit: ANSI C80.5.
D. IMC: ANSI C80.6.
E. EMT and Fittings: ANSI C80.3.
   1. Fittings: Set-screw or compression steel type.
F. FMC: Zinc-coated steel.
G. LFMC: Flexible steel conduit with PVC jacket.
H. Fittings: NEMA FB 1; compatible with conduit and tubing materials.
2.3 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers:
   2. Anamet Electrical, Inc.; Anaconda Metal Hose.
   3. Arnco Corp.
   4. Cantex Inc.
   7. ElecSYS, Inc.
   8. Electri-Flex Co.
   9. Lamson & Sessions; Carlon Electrical Products.
   10. Manhattan/CDT/Cole-Flex.
   11. RACO; Division of Hubbell, Inc.
   12. Spiralduct, Inc./AFC Cable Systems, Inc.

B. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.

C. RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.

D. Support Clamps for PVC Raceways: Snap type hanger, capable of allowing expansion and contraction of raceway.

2.4 METAL WIREWAYS

A. Manufacturers:
   1. Hoffman.
   2. Square D.

B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

E. Wireway Covers: Screw-cover type.

F. Finish: Manufacturer's standard enamel finish.

2.5 NONMETALLIC WIREWAYS

A. Manufacturers:
1. Hoffman.
2. Lamson & Sessions; Carlon Electrical Products.

B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.

C. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.

D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

E. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

2.6 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.

1. Manufacturers:
   a. Airey-Thompson Sentinel Lighting; Wiremold Company (The).
   b. Thomas & Betts Corporation.
   d. Wiremold Company (The); Electrical Sales Division.

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC compound with matte texture and manufacturer's standard color.

1. Manufacturers:
   b. Enduro Composite Systems.
   c. Hubbell, Inc.; Wiring Device Division.
   d. Lamson & Sessions; Carlon Electrical Products.
   e. Panduit Corp.
   g. Wiremold Company (The); Electrical Sales Division.

C. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.7 BOXES, ENCLOSURES, AND CABINETS
A. Manufacturers:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. Emerson/General Signal; Appleton Electric Company.
3. Erickson Electrical Equipment Co.
6. O-Z/Gedney; Unit of General Signal.
7. RACO; Division of Hubbell, Inc.
10. Spring City Electrical Manufacturing Co.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

E. Floor Boxes: Cast metal, fully adjustable, rectangular. Provide carpet flange with brass cover plates that can be closed flush with cabling or receptacle usage.

1. Manufacturer: Legrand (refer to technology drawings and specs).

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

H. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

I. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.8 FACTORY FINISHES

A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION
3.1 RACEWAY APPLICATION

A. Outdoors:
   1. Exposed: Rigid steel or IMC.
   2. Concealed: Rigid steel or IMC.
   3. Underground, Single Run: RNC.
   4. Underground, Grouped: RNC.
   5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   6. Boxes and Enclosures: NEMA 250, Type 3R.

B. Indoors:
   1. Exposed: EMT.
   2. Concealed: EMT or RNC (installed below slab on grade).
   3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
   4. Damp or Wet Locations: Rigid steel conduit.
   5. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
      a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel.

C. Minimum Raceway Size: 3/4-inch trade size (DN 21).

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits embedded in or in contact with concrete.

3.2 INSTALLATION

A. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

B. Complete raceway installation before starting conductor installation.

C. Support raceways as specified in Division 26 Section "Basic Electrical Materials and Methods."

D. Install temporary closures to prevent foreign matter from entering raceways.

E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
F. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
   1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

H. Raceways Below Slabs: Install below slab and leave at least 2 inches (50 mm) of rock cover except where conduit penetrates the surface.
   1. Secure raceways to reinforcing rods to prevent sagging or shifting during rock placement.
   2. Space raceways laterally to prevent voids in rockl.
   3. Run conduit larger than 1-inch trade size (DN 27) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   4. Change from nonmetallic tubing to rigid steel conduit, before rising above the floor.

I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
   1. Run parallel or banked raceways together on common supports.
   2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

J. Join raceways with fittings designed and approved for that purpose and make joints tight.
   1. Use insulating bushings to protect conductors.

K. Tighten set screws of threadless fittings with suitable tools.

L. Terminations:
   1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
   2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.

N. Telephone and Signal System Raceways, 2-Inch Trade Size (DN 53) and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet (45 m) and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
O. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

P. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

Q. Flexible Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.

R. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.

S. Set floor boxes level and flush with finished floor surface.

T. Set floor boxes level. Trim after installation to fit flush with finished floor surface.

U. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

V. Height of outlets and devices are indicated on the drawings. Comply with “Americans with Disabilities Act” (ADA).

3.3 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.4 CLEANING
A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 26 05 33
SECTION 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Direct-buried conduit, ducts, and duct accessories.
   2. Concrete-encased conduit, ducts, and duct accessories.
   3. Handholes and boxes.

1.3 DEFINITIONS

A. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include duct-bank materials, including separators and miscellaneous components.
   2. Include ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
   3. Include accessories for manholes, handholes, boxes, and other utility structures.
   4. Include warning tape.
   5. Include warning planks.

B. Shop Drawings:
   1. Precast or Factory-Fabricated Underground Utility Structures:
      a. Include plans, elevations, sections, details, attachments to other work, and accessories.
      b. Include duct entry provisions, including locations and duct sizes.
      c. Include reinforcement details.
      d. Include frame and cover design and manhole frame support rings.
      e. Include ladder details.
      f. Include grounding details.
      g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
h. Include joint details.

2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
   a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
   b. Include duct entry provisions, including locations and duct sizes.
   c. Include cover design.
   d. Include grounding details.
   e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.5 INFORMATIONAL SUBMITTALS

   A. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

      1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
      2. Drawings shall be signed and sealed by a qualified professional engineer.

   B. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.

   C. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.

   D. Source quality-control reports.

   E. Field quality-control reports.

1.6 MAINTENANCE MATERIALS SUBMITTALS

   A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

1.7 QUALITY ASSURANCE

   A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.8 FIELD CONDITIONS
A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Construction Manager's and Owner's written permission.

B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

C. Ground Water: Assume ground-water level is 36 inches (900 mm) below ground surface unless a higher water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR DUCTS AND RACEWAYS

A. Comply with ANSI C2.

2.2 CONDUIT


B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.3 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Manufacturers:

1. ARNCO Corporation.
2. Beck Manufacturing.
3. CANTEX, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX USA, LLC.
10. Manhattan/CDT.
11. Spiraduct/AFC Cable Systems, Inc.
B. Underground Plastic Utilities Duct: NEMA TC 2, UL 651, ASTM F 512, Type EPC-80 and Type EPC-40, with matching fittings complying with NEMA TC 3 by same manufacturer as the duct.

C. Underground Plastic Utilities Duct: NEMA TC 6 & 8, ASTM F 512, UL 651A, Type HDPE and Type EB-20-PVC, with matching fittings complying with NEMA TC 9 by same manufacturer as the duct.

D. Underground Plastic Utilities Duct: NEMA TC 6 & 8, ASTM F 512, Type DB-60-PVC and Type DB-120-PVC, for direct burial, with matching fittings complying with NEMA TC 9 by same manufacturer as the duct.

E. Duct Accessories:
   1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of ducts with which used, and selected to provide minimum duct spacing indicated while supporting ducts during concreting or backfilling.
   3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 75 mm) in size, manufactured from 6000-psi (41-MPa) concrete.
      b. Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.

2.4 PRECAST CONCRETE HANDHOLES AND BOXES

A. Manufacturers:
   1. Christy Concrete Products.
   2. Elmhurst-Chicago Stone Co.
   3. Oldcastle Precast, Inc.
   4. Rinker Group, Ltd.
   5. Riverton Concrete Products.
   6. Utility Concrete Products, LLC.
   8. Wausau Tile, Inc.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
   1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
   2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
   a. Cover Hinges: Concealed, with hold-open ratchet assembly.
   b. Cover Handle: Recessed.

4. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
   a. Cover Hinges: Concealed, with hold-open ratchet assembly.
   b. Cover Handle: Recessed.

5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

6. Cover Legend: Molded lettering, "ELECTRIC." As indicated for each service.

7. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

8. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
   a. Extension shall provide increased depth of 12 inches (300 mm).
   b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

9. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

10. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks, plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
    a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
    b. Window opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
    c. Window openings shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.

11. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
    a. Type and size shall match fittings to duct or conduit to be terminated.
    b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.

12. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
A. General Requirements for Handholes and Boxes: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

2. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC."
6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
8. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Manufacturers:
   a. Armorcast Products Company.
   b. Carson Industries, LLC.
   c. NewBasis.

C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

1. Manufacturers:
   a. Armorcast Products Company.
   b. Carson Industries, LLC.
   c. Christy Concrete Products.
   e. Synertech Moulded Products.

D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers made of polymer concrete.

1. Manufacturers:
   a. Carson Industries, LLC.
   b. Christy Concrete Products.
   c. Nordic Fiberglass, Inc.
2.6 PRECAST MANHOLES

A. Manufacturers:

1. Carder Concrete Products.
2. Christy Concrete Products.
3. Elmhurst-Chicago Stone Co.
4. Oldcastle Precast, Inc.
5. Rinker Group, Ltd.
6. Riverton Concrete Products.
7. Utility Concrete Products, LLC.
8. Utility Vault Co.
9. Wausau Tile, Inc.

B. Comply with ASTM C 858.

C. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.

D. Precast Manholes: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.

E. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks, plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.

1. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
2. Window opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
3. Window openings shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.

F. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

1. Type and size shall match fittings to duct or conduit to be terminated.
2. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.

G. Concrete Knockout Panels: 1-1/2 to 2 inches (38 to 50 mm) thick, for future conduit entrance and sleeve for ground rod.

H. Ground Rod Sleeve: Provide a 3-inch (75-mm) PVC conduit sleeve in manhole floors 2 inches (50 mm) from the wall adjacent to, but not underneath, the ducts routed from the facility.

I. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
2.7 CAST-IN-PLACE MANHOLES

A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod.

B. Materials: Comply with ASTM C 858 and with Section 033000 "Cast-in-Place Concrete."


2.8 UTILITY STRUCTURE ACCESSORIES

A. Manufacturers:

1. Bilco Company (The).
2. Campbell Foundry Company.
3. Carder Concrete Products.
4. Christy Concrete Products.
5. East Jordan Iron Works, Inc.
7. McKinley Iron Works, Inc.
13. Rinker Group, Ltd.
14. Riverton Concrete Products.
15. Underground Devices, Inc.
16. Utility Concrete Products, LLC.
17. Utility Vault Co.
18. Wausau Tile, Inc.

B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.

1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 29 inches (725 mm).
   a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.

2. Cover Legend: Cast in. Selected to suit system.
   a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
   b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
   a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C 387, Type M, may be used.
   b. Seal joints watertight using preformed plastic or rubber conforming to ASTM C 990. Install sealing material according to the sealant manufacturers' printed instructions.

C. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.

D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.
   1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.

E. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- (31-mm-) diameter eye, rated 2500-lbf (11-kN) minimum tension.

F. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
   1. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension.

G. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch (13-mm) ID by 2-3/4 inches (69 mm) deep, flared to 1-1/4 inches (31 mm) minimum at base.
   1. Tested Ultimate Pullout Strength: 12,000 lbf (53 kN) minimum.

H. Ground Rod Sleeve: 3-inch (75-mm), PVC conduit sleeve in manhole floors 2 inches (50 mm) from the wall adjacent to, but not underneath, the ducts routed from the facility.

I. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch (13-mm) bolt, 5300-lbf (24-kN) rated pullout strength, and minimum 6800-lbf (30-kN) rated shear strength.

J. Cable Rack Assembly: Steel, hot-rolled galvanized, except insulators.
   1. Stanchions: T-section or channel; 2-1/4-inch (56-mm) nominal size; punched with 14 holes on 1-1/2-inch (38-mm) centers for cable-arm attachment.
   2. Arms: 1-1/2 inches (38 mm) wide, lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 18 inches (450 mm) with 250-lb (114-kg) minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
   1. Stanchions: Nominal 36 inches (900 mm) high by 4 inches (100 mm) wide, with minimum of nine holes for arm attachment.
   2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 20 inches (500 mm) with 250-lb (114-kg) minimum capacity. Top of arm shall be nominally 4 inches (100 mm) wide, and arm shall have slots along full length for cable ties.

L. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

M. Fixed Manhole Ladders: Arranged for attachment to roof or wall and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from hot-dip galvanized steel.

N. Portable Manhole Ladders: UL-listed, heavy-duty fiberglass specifically designed for portable use for access to electrical manholes. Minimum length equal to distance from deepest manhole floor to grade plus 36 inches (900 mm). One required.

O. Cover Hooks: Heavy duty, designed for lifts 60 lbf (270 N) and greater. Two required.

2.9 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
   1. Tests of materials shall be performed by an independent testing agency.
   2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
   3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

3.2 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-80-PVC, in concrete-encased duct bank unless otherwise indicated.

B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-80-PVC, in direct-buried duct bank unless otherwise indicated.

C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-80-PVC, in direct-buried duct bank unless otherwise indicated.


3.3 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
2. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
3. Units Subject to Light-Duty Pedestrian Traffic Only: High-density plastic, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.
4. Cover design load shall not exceed the design load of the handhole or box.

B. Manholes: Precast concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.4 EARTHWORK
A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to the "Cutting and Patching" Article in Section 017300 "Execution."

3.5 DUCT INSTALLATION

A. Install ducts according to NEMA TCB 2.

B. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes, to drain in both directions.

C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches (1200 mm), both horizontally and vertically, at other locations unless otherwise indicated.

D. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

E. Installation Adjacent to High-Temperature Steam Lines: Where duct banks are installed parallel to underground steam lines, perform calculations showing the duct bank will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct bank crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.

F. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.

2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct banks with calculated expansion of more than 3/4 inch (19 mm).

3. Grout end bells into structure walls from both sides to provide watertight entrances.

G. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall, without reducing duct line slope away from the
building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

H. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

I. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in empty ducts.

J. Concrete-Encased Ducts: Support ducts on duct separators.

1. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches (150 mm) in nominal diameter.
2. Width: Excavate trench 12 inches (300 mm) wider than duct bank on each side.
3. Width: Excavate trench 3 inches (75 mm) wider than duct bank on each side.
4. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
5. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
6. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than five spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
7. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.
8. Elbows: Use manufactured duct elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run unless otherwise indicated. Extend concrete encasement throughout length of elbow.
9. Elbows: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
   b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
10. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
11. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
12. Concrete Cover: Install a minimum of 3 inches (75 mm) of concrete cover at top and bottom, and a minimum of 2 inches (50 mm) on each side of duct bank.
13. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
   a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
   b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (15-mm) reinforcing-rod dowels extending a minimum of 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.

14. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

K. Direct-Buried Duct Banks:

1. Excavate trench bottom to provide firm and uniform support for duct bank. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inches (150 mm) in nominal diameter.
2. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
3. Space separators close enough to prevent sagging and deforming of ducts, with not less than five spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches (150 mm) between tiers.
4. Depth: Install top of duct bank at least 36 inches (900 mm) below finished grade unless otherwise indicated.
5. Set elevation of bottom of duct bank below frost line.
6. Install ducts with a minimum of 3 inches (75 mm) between ducts for like services and 6 inches (150 mm) between power and signal ducts.
7. Elbows: Install manufactured duct elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
8. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
   b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
9. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing
each tier. After placing last tier, hand place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.

a. Place minimum 3 inches (75 mm) of sand as a bed for duct bank. Place sand to a minimum of 6 inches (150 mm) above top level of duct bank.

b. Place minimum 6 inches (150 mm) of engineered fill above concrete encasement of duct bank.

L. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried ducts and duct banks, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional planks 12 inches (300 mm) apart, horizontally.

M. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:

1. Finish interior surfaces with a smooth-troweled finish.
2. Windows for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches (38 to 50 mm) thick, arranged as indicated.
3. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.

B. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts, to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches (375 mm) below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch (25 mm) above finished grade.
3. Install handholes with bottom below frost line, 42 inches (1067 mm) below grade.
4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. Manhole Access: Circular opening in manhole roof; sized to match cover size.
   1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
   2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.

F. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Section 071353 "Elastomeric Sheet Waterproofing." After ducts have been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

G. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 071113 "Bituminous Dampproofing." After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

H. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

I. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

J. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (97 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.

D. Install handholes and boxes with bottom below frost line, 42 inches (1067 mm) below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
   1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with a troweled finish.
   2. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).

3.8 GROUNDING

A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:
   1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
   2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 6-inch- (150-mm-) long mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
   3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.10 CLEANING
A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 26 05 43
SECTION 26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLELING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
   2. Sleeve-seal systems.
   5. Silicone sealants.

B. Related Requirements:
   1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
   1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
   2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
C. Sleeves for Rectangular Openings:
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and
         with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3
         mm).
      b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one
         or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5
         mm).

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between
   sleeve and raceway or cable.
   1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include
      type and number required for pipe material and size of pipe.
   2. Pressure Plates: Carbon steel.
   3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length
      required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in
   concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to
   match piping OD.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-
   rated walls or floors.
   B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry,
      hydraulic-cement grout.
   C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
   D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of
   grade indicated below.
SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
2. Sealant shall have VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.
B. Comply with NEMA VE 2 for cable tray and cable penetrations.
C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
      b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
   2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
   4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
   1. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 05 44
PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid:
   1. Electrical Contractor shall provide electrical identification materials and devices required to comply with ANSI C2, NFPA 70, and authorities having jurisdiction.

B. Alternate Bid:
   1. None.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 QUALITY ASSURANCE


B. Comply with NFPA 70 and all appendices.


1.4 COORDINATION


B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.
PART 2 - PRODUCTS

2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Color for Printed Legend:
   1. Power Circuits: Black letters on an orange field.
   2. Legend: Indicate system or service and voltage, if applicable.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

C. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- (0.35-mm-) thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.

D. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking nylon tie fastener.

E. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2.3 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.

1. Not less than 6 inches (150 mm) wide by 4 mils (0.102 mm) thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend shall indicate type of underground line.

2.4 WARNING LABELS AND SIGNS


B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.5 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 EQUIPMENT IDENTIFICATION LABELS
A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and ultraviolet-resistant seal for label.

C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
   1. Minimum Width: 3/16 inch (5 mm).
   2. Tensile Strength: 50 lb (22.6 kg), minimum.
   3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

B. Paint: Paint materials and application requirements are specified in Division 9 painting Sections.
   1. Exterior Concrete, Stucco, and Masonry (Other Than Concrete Unit Masonry):
      a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
         1) Primer: Exterior concrete and masonry primer.
         2) Finish Coats: Exterior semigloss acrylic enamel.

2. Exterior Concrete Unit Masonry:
   a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
   1) Block Filler: Concrete unit masonry block filler.
   2) Finish Coats: Exterior semigloss acrylic enamel.

3. Exterior Ferrous Metal:
   a. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Exterior ferrous-metal primer.
      2) Finish Coats: Exterior semigloss alkyd enamel.

4. Exterior Zinc-Coated Metal (except Raceways):
a. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
   1) Primer: Exterior zinc-coated metal primer.
   2) Finish Coats: Exterior semigloss alkyd enamel.

5. Interior Concrete and Masonry (Other Than Concrete Unit Masonry):
   a. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Interior concrete and masonry primer.
      2) Finish Coats: Interior semigloss alkyd enamel.

6. Interior Concrete Unit Masonry:
   a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
      1) Block Filler: Concrete unit masonry block filler.
      2) Finish Coats: Interior semigloss acrylic enamel.

7. Interior Gypsum Board:
   a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Interior gypsum board primer.
      2) Finish Coats: Interior semigloss acrylic enamel.

8. Interior Ferrous Metal:
   a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Interior ferrous-metal primer.
      2) Finish Coats: Interior semigloss acrylic enamel.

9. Interior Zinc-Coated Metal (except Raceways):
   a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Interior zinc-coated metal primer.
      2) Finish Coats: Interior semigloss acrylic enamel.

C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

A. Raceways and Duct Banks More Than 600 V Concealed within Buildings: 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers over orange background that extends full length
of raceway or duct and is 12 inches (300 mm) wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high black letters on 20-inch (500-mm) centers. Stop stripes at legends. Apply to the following finished surfaces:

1. Floor surface directly above conduits running beneath and within 12 inches (300 mm) of a floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to raceways concealed within wall.
3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

B. Accessible Raceways and Metal-Clad Cables More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches (50 mm) high, with self-adhesive vinyl labels. Repeat legend at 10-foot (3-m) maximum intervals.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identify with orange self-adhesive vinyl label.

D. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:

1. Fire Alarm System: Red.
5. Mechanical and Electrical Supervisory System: Green and blue.
7. Control Wiring: Green and red.

E. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

F. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use marker tape. Identify each ungrounded conductor according to source and circuit number.

G. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source and circuit number.


1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
   a. Power transfer switches.
   b. Controls with external control power connections.

2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

K. Instruction Signs:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.

L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:
   a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where 2 lines of text are required, use labels 2 inches (50 mm) high.
   b. Outdoor Equipment: Engraved, laminated acrylic or melamine.
   c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:
   a. Panelboards, electrical cabinets, and enclosures.
   b. Access doors and panels for concealed electrical items.
   c. Electrical switchgear and switchboards.
d. Transformers.
e. Electrical substations.
f. Emergency system boxes and enclosures.
g. Motor-control centers.
h. Disconnect switches.
i. Enclosed circuit breakers.
j. Motor starters.
k. Push-button stations.
l. Power transfer equipment.
m. Contactors.
n. Remote-controlled switches, dimmer modules, and control devices.
o. Battery inverter units.
p. Battery racks.
q. Power-generating units.
r. Voice and data cable terminal equipment.
s. Master clock and program equipment.
t. Intercommunication and call system master and staff stations.
u. Television/audio components, racks, and controls.
v. Fire-alarm control panel and annunciators.
w. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
x. Monitoring and control equipment.
y. Uninterruptible power supply equipment.
z. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
G. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.

H. Circuit Identification Labels on Boxes: Install labels externally.
   1. Exposed Boxes: Permanent, waterproof marker labeling on exterior cover.
   3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

I. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
   1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
   2. Colors for 208/120-V Circuits:
      a. Phase A: Black.
      b. Phase B: Red.
      c. Phase C: Blue.
      e. Ground: Green.
   3. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

J. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

K. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

L. Painted Identification: Prepare surface and apply paint according to Division 9 painting Sections.

END OF SECTION 26 05 53
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Photoelectric switches.
   2. Standalone daylight-harvesting switching controls.
   3. Indoor occupancy sensors.
   4. Lighting contactors.
   5. Emergency shunt relays.

B. Related Requirements:

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.
   1. Interconnection diagrams showing field-installed wiring.
   2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.
PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers:

1. Acuity Brands.
2. Crestron.
3. Hubbell Building Automation
4. Leviton.

B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
3. Time Delay: Fifteen second minimum, to prevent false operation.
5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.2 INDOOR OCCUPANCY SENSORS

A. Manufacturers:

1. Acuity Brands.
2. Crestron.
3. Hubbell Building Automation
4. Leviton.

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
5. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.

7. Bypass Switch: Override the "on" function in case of sensor failure.

8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.

C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 108-inch- (2743-mm-) high ceiling.

2.3 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Manufacturers:

1. Acuity Brands.
2. Crestron.
4. Leviton.

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

C. Wall-Switch Sensor Tag OS:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 1000 sq. ft. (92 sq. m).
2. Sensing Technology: Dual technology-pir and ultrasound.
3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."
4. Voltage: 120 V; dual technology type.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

D. Wall-Switch Sensor Tag OSD:
1. Standard Range: 180-degree field of view, with a minimum coverage area of 1000 sq. ft. (92 sq. m).
2. Sensing Technology: PIR.
3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."
4. Voltage: 120 V; passive-infrared type.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 500 fc (108 to 5400 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
9. Dimming: 0-10 V, 3-wire.

2.4 EMERGENCY SHUNT RELAY

A. Manufacturers:
1. Acuity.
2. Bodine.
3. Crestron.

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. Coil Rating: 120 V.

2.5 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Section 26 05 53 "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Lighting control devices will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.7 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 26 09 43.13 "Addressable-Fixture Lighting Controls" and Section 26 09 43.23 "Relay-Based Lighting Controls."

B. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 09 23
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Lighting controls using electrically operated circuit breakers.

1.2 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

B. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

C. RS-485: A serial network protocol, similar to RS-232, complying with TIA-485-A.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For each lighting control panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.

2. Detail bus configuration, current, and voltage ratings.


1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer’s special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.

2. Program Software Backup: On magnetic media or compact disk, complete with data files.

3. Printout of software application and graphic screens.

4. Device address list.
1.6 QUALITY ASSURANCE
   A. Testing Agency Qualifications: Member company of NETA or an NRTL.
       1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 WARRANTY
   A. Special Warranty: Manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
       1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION
   A. Input signal from field-mounted or on-board signal source shall open or close one or more electrically operated circuit breakers in the lighting control panelboards. Any combination of inputs shall be programmable to any combination outputs.

   B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

   C. Comply with 47 CFR, Subpart A and Subpart B, for Class A digital devices.

2.2 PANELBOARDS
   A. The lighting panelboards may contain remotely operated circuit breakers and standard branch circuit breakers specified in Section 262416 "Panelboards."

   B. Assemblies: Comply with UL 67 and NEMA PB 1.

   C. Surge Protective Device: Integrally mounted, complying with UL 1449 Type 1.
      2. Non-modular type with the following features and accessories:
         a. Digital-display indicator lights for power and protection status.

   D. Enclosures: Comply with UL 50 and NEMA 250.

   E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

2.3 CIRCUIT BREAKERS

A. Remotely operated branch circuit breakers used for lighting control shall provide branch-circuit overcurrent protection.

B. Labeled with SWD and HID Ratings: Comply with UL 489 for 15- and 20-A, single-pole branch devices.

C. Switching Endurance Rating: Not less than 50,000 full-load open/close/open remote operations.

D. Remotely Operated Circuit Breakers: Manual override switch or handle position shall enable or disable the remote operation of the device and allow breaker handle to manually control the breaker's on-off status.

2.4 CONTROLLERS

A. Description: Controllers shall contain the power supply and electronic control for operating and monitoring remotely operated branch circuit breakers.

1. Comply with UL 916; with a microprocessor-based, solid-state, 365-day timing and control unit.
2. Power Supply: Powered from the panelboard, sized to provide control power for the operation of the remotely operated circuit breakers, controller, bus system, low-voltage inputs, field-installed occupancy sensors, and low-voltage photo sensors.
3. Integral keypad and digital-display front panel for local setup, including the following:
   a. Blink notice, time adjustable from software.
   b. Ability to log and display remotely operated breaker on-time.
   c. Capability for accepting downloadable firmware so that the latest production features may be added in the future without replacing the module.
4. Nonvolatile memory shall retain all setup configurations. After a power failure, the controller shall automatically reboot and return to normal system operation.
5. Time Synchronization: The timing unit shall be updated not less than every two hour(s) with the network time server.

B. Timing Unit:

1. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
2. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
3. 16 independent schedules, each having 24 time periods.
4. Schedule periods settable to the minute.
5. Day of week, day of month, day of year with one-time or repeating capability.
6. 32 special date periods.

C. With 16 inputs, each configurable to the following parameters:
1. Normally open, normally closed, two-wire maintained toggle, two-wire momentary toggle, two-wire momentary on, two-wire momentary off, or three-wire momentary operation.
2. On and off-delay timers for local override operation, adjustable from five minutes to 12 hours. Local override shall be by field-installed, two-wire momentary toggle switch.

2.5 MANUAL SWITCHES AND PLATES

A. Keypads: Programmable, designed to control lighting applications and functions associated with the equipment of this Section. The units shall be able to control any system output device, including remotely operated circuit breakers, relays, dimmers, and analog outputs.

B. Push-Button Switches: Modular, momentary-contact, low-voltage type.
   1. Match color specified in Section 262726 "Wiring Devices."
   2. Integral green LED pilot light to indicate when circuit is on.
   3. Internal white LED locator light to illuminate when circuit is off.

C. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Section 262726 "Wiring Devices."

D. Wall Plates: Single and multigang plates as specified in Section 262726 "Wiring Devices."

E. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.6 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Class 2 and Class 3 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

A. Comply with NECA 1.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.2 PANELBOARD INSTALLATION

A. Comply with NECA 1.
B. Install panelboards and accessories according to NECA 407.
C. Mounting Height: 80 inches (2032 mm) to top of trim above finished floor unless otherwise indicated.
D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
E. Install filler plates in unused spaces.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
C. Create a directory to indicate loads served by each circuit; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are unacceptable.
D. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.

C. Acceptance Testing Preparation:

   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

D. Panelboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.5 DEMONSTRATION

   A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain control modules.

END OF SECTION 26 09 26
SECTION 26 09 36.19 - STANDALONE MULTIPRESET MODULAR DIMMING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes wall-box multiscene dimming controls.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Shop Drawings:
   1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS
A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 GENERAL DIMMING DEVICE REQUIREMENTS
A. Compatibility:
   1. Dimming control components shall be compatible with lighting fixtures, ballasts, and transformers.
   2. Dimming control devices shall be compatible with lighting control system components specified in Section 260943.13 "Addressable-Fixture Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls," and in Section 260923 "Lighting Control Devices."
B. Dimmers and Dimmer Modules: Comply with UL 508.
   1. Audible Noise and Radio-Frequency Interference Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible lamp or dimmer noise or radio-frequency interference. Modules shall include integral or external filters to suppress audible noise and radio-frequency interference.
   2. Dimmer or Dimmer-Module Rating: Not less than 125 percent of connected load unless otherwise indicated.
C. Surge Protection: Withstand supply power surges without impairment to performance.

D. Off Control Position: User-selected off position of any control point shall disconnect the load from line supply.

2.2 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

2.3 WALL-BOX MULTISCENE DIMMING CONTROLS

A. Description: Factory-fabricated equipment providing manual dimming consisting of a wall-box-mounted master controller and indicated number of wall-box zone stations. Controls and dimmers shall be integrated for mounting in multigang wall box under a single wall plate. Each zone shall be adjustable to indicated number of scenes, which shall reside in the memory of zone controller.

B. Each zone shall be configurable to control the following loads:

1. Fluorescent lamps with electronic ballasts.
2. Incandescent lamps.
3. Low-voltage incandescent lamps, derived with electronic transformers.
4. Non-dim, on-off switching only.

C. Dimmers: Regulate voltages to maintain a constant light level, with no visible flicker, when the source voltage varies plus or minus 2 percent rms.

D. Memory:

1. Retain preset scenes and fade rates through momentary (up to 3-second) power interruptions.
2. Retain preset scenes through power failures for at least seven days.

E. Device Plates: Style, material, and color shall comply with Section 262726 "Wiring Devices." Master-control cover plate shall be one piece.

F. Master controller shall include the following:

1. Cover-mounted switches, including master off, all bright, and selectors for each scene.
2. Cover-mounted LED indicator lights, one associated with each scene switch, and one for the master off switch.
3. Concealed switches and indicators for specified function.
4. A raise/lower switch for each zone for temporary adjustments of the zone, without altering scene values stored in memory.
5. Fade time indicated by digital display for current scene while fading.
6. Cover-mounted infrared receiver.

G. Infrared Transmitters: Wireless remote control for recalling each of the presets. Operate up to 50 feet (15 m) within line of sight of the master controller.

2.4 CONDUCTORS AND CABLES

A. Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Class 2 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.2 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identifying components and power and control wiring.

B. Label each dimmer module with a unique designation.

C. Label each scene control button with approved scene description.
3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Continuity tests of circuits.
2. Operational Test: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
   a. Include testing of modular dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

B. Remove and replace malfunctioning modular dimming control components and retest as specified above.

C. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

D. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

END OF SECTION 26 09 36.19
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section Includes: Lighting control panels using mechanically held relays for switching.
   B. Section Includes: Networked lighting control panels using control-voltage relays for switching and that are interoperable with DDC system for HVAC.

1.3 DEFINITIONS
   A. DDC: Direct digital control.
   B. IP: Internet protocol.
   C. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
   D. PC: Personal computer; sometimes plural as "PCs."
   E. RS-485: A serial network protocol, similar to RS-232, complying with TIA-485-A.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product.
      1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, relays, manual switches and plates, and conductors and cables.
      2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   B. Shop Drawings: For each relay panel and related equipment.
      1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
      2. Detail enclosure types and details for types other than NEMA 250, Type 1.
      3. Detail wiring partition configuration, current, and voltage ratings.
4. Short-circuit current rating of relays.
5. Include diagrams for power, signal, and control wiring.
6. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
   1. Show interconnecting signal and control wiring, and interface devices that prove compatibility of inputs and outputs.
   2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the network protocol.

B. Qualification Data: For testing agency.

C. Field quality-control reports.

D. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.

E. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On magnetic media or compact disk, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lighting Control Relays: Equal to 10 percent of amount installed for each size indicated, but no fewer than 1.
1.8 QUALITY ASSURANCE
   A. Testing Agency Qualifications: Member company of NETA or an NRTL.
      1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING
   A. Handle and prepare panels for installation according to NECA 407.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION
   A. Input signal from field-mounted manual switches, or digital signal sources, shall open or close one or more lighting control relays in the lighting control panels. Any combination of inputs shall be programmable to any number of control relays.
   B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.
   D. Comply with UL 916.

2.2 LIGHTING CONTROL RELAY PANELS
   A. Manufacturers:
      1. Acuity Brands.
      2. Crestron.
      4. Leviton.
   B. Description: Standalone lighting control panel using mechanically latched relays to control lighting and appliances.
   C. Lighting Control Panel:
      1. A single enclosure with incoming lighting branch circuits, control circuits, switching relays, and on-board timing and control unit.
      2. A vertical barrier separating branch circuits from control wiring.
   D. Control Unit: Contain the power supply and electronic control for operating and monitoring individual relays.
      1. Timing Unit:
a. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
b. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
c. Four independent schedules, each having 24 time periods.
d. Schedule periods settable to the minute.
e. Day-of-week, day-of-month, day-of-year with one-time or repeating capability.
f. 10 special date periods.

2. Sequencing Control with Override:
   a. Automatic sequenced on and off switching of selected relays at times set at the timing unit, allowing timed overrides from external switches.
   b. Sequencing control shall operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.
   c. Override control shall allow any relay connected to it to be switched on or off by a field-deployed manual switch or by an automatic switch, such as an occupancy sensor.

3. Nonvolatile memory shall retain all setup configurations. After a power failure, the controller shall automatically reboot and return to normal system operation, including accurate time of day and date.

E. Relays: Electrically operated, mechanically held single-pole switch, rated at 20 A at 277 V. Short-circuit current rating shall be not less than 5 kA. Control shall be three-wire, 24-V ac.

F. Relays: Electrically operated, mechanically held single-pole switch, rated at 20 A at 120-V tungsten, 30 A at 277-V ballast, 1.5 hp at 120 V, and 3 hp at 277 V. Short-circuit current rating shall be not less than 14 kA. Control shall be three-wire, 24-V ac.

G. Power Supply: NFPA 70, Class 2, sized for connected equipment, plus 20 percent spare capacity. Powered from a dedicated branch circuit of the panelboard that supplies power to the line side of the relays, sized to provide control power for the local panel-mounted relays, bus system, low-voltage inputs, field-installed occupancy sensors, and photo sensors.

H. Operator Interface:
   1. Integral alphanumeric keypad and digital display, and intuitive drop-down menus to assist in programming.
   2. Log and display relay on-time.
   3. Connect relays to one or more time and sequencing schemes.

2.3 MANUAL SWITCHES AND PLATES

A. Push-Button Switches: Modular, momentary contact, three wire, for operating one or more relays and to override automatic controls.
   1. Match color and style specified in Section 26 27 26 "Wiring Devices."
   2. Integral green LED pilot light to indicate when circuit is on.
B. Wall Plates: Single and multigang plates as specified in Section 26 27 26 "Wiring Devices."

C. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.4 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

D. Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, Category 5e for horizontal copper cable and with Section 27 15 00 "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panels according to NECA 407.

B. Examine panels before installation. Reject panels that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panels for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."

C. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 PANEL INSTALLATION

A. Comply with NECA 1.

B. Install panels and accessories according to NECA 407.

C. Comply with mounting and anchoring requirements specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."

D. Mount top of trim 72 inches (2 m) above finished floor unless otherwise indicated.

E. Mount panel cabinet plumb and rigid without distortion of box.

F. Install filler plates in unused spaces.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 26 05 53 "Identification for Electrical Systems."

C. Create a directory to indicate loads served by each relay; incorporate Owner's final room designations. Obtain approval before installing. Use a PC or typewriter to create directory; handwritten directories are unacceptable.

D. Lighting Control Panel Nameplates: Label each panel with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
C. Perform the following tests and inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Acceptance Testing Preparation:
   1. Test continuity of each circuit.

E. Lighting control panel will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies lighting control panels and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Confirm correct communications wiring, initiate communications between panels, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.8 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
   1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.
3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain the control unit and operator interface.

END OF SECTION 26 09 43.23
PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid:
   1. Electrical Contractor shall provide panelboards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less.

B. Alternate Bid:
   1. None.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections:
   1. Division 26 Section “Fuses.”

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. RFI: Radio-frequency interference.

D. RMS: Root mean square.

E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
B. Shop Drawings: For each panelboard and related equipment.
   1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Enclosure types and details for types other than NEMA 250, Type 1.
      b. Bus configuration, current, and voltage ratings.
      c. Short-circuit current rating of panelboards and overcurrent protective devices.
      d. UL listing for series rating of installed devices.
      e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   2. Wiring Diagrams: Power, signal, and control wiring.

C. Qualification Data: For testing agency.

D. Field quality-control test reports including the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NEMA PB 1.
E. Comply with NFPA 70 and all appendices.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not exceeding 104 deg F (40 deg C).

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet (2000 m).

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Construction Manager's and Owner's written permission.

1.7 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Six spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
   a. Eaton Corporation; Cutler-Hammer Products.
   c. Siemens Energy & Automation, Inc.
   d. Square D.

2.2 MANUFACTURED UNITS

   A. Enclosures: Surface-mounted cabinets. NEMA PB 1, Type 1.
      1. Rated for environmental conditions at installed location.
         a. Outdoor Locations: NEMA 250, Type 3R.
         c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
         d. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.
      2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
      3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
      4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
      5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
      6. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.
      7. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.

   B. Phase and Ground Buses:
      2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
      3. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.
      4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.

   C. Conductor Connectors: Suitable for use with conductor material.
      1. Main and Neutral Lugs: Mechanical type.
      2. Ground Lugs and Bus Configured Terminators: Compression type.
      3. Feed-Through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
4. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

D. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.

E. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

2.3 PANELBOARD SHORT-CIRCUIT RATING

A. UL label indicating series-connected rating with integral or remote upstream overcurrent protective devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.

B. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 DISTRIBUTION PANELBOARDS

A. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.

B. Main Overcurrent Protective Devices: Circuit breaker.

C. Branch Overcurrent Protective Devices:
   1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
   2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
   3. Fused switches.

2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.6 TRANSIENT VOLTAGE SUPPRESSION REQUIREMENTS


   1. Minimum Single-Impulse Current Ratings:
      a. Line to Neutral: 100,000 A.
b. Line to Ground: 100,000 A.
c. Neutral to Ground: 50,000 A.

2. Protection modes shall be as follows:
   a. Line to neutral.
   b. Line to ground.
   c. Neutral to ground.

3. EMI/RFI Noise Attenuation Using 50-ohm Insertion Loss Test: 55 dB at 100 kHz.
4. Maximum Category C Combination Wave Clamping Voltage: 600 V, line to neutral and line to ground on 120/208 V systems.
5. Maximum UL 1449 Clamping Levels: 400 V, line to neutral and line to ground on 120/208 V systems.
6. Withstand Capabilities: 3000 Category C surges with less than 5 percent change in clamping voltage.
7. Accessories:
   a. Form-C contacts, one normally open and one normally closed, for remote monitoring of system operation. Contacts to reverse position on failure of any surge diversion module.
   b. Audible alarm activated on failure of any surge diversion module.
   c. Six-digit transient-counter set to total transient surges that deviate from the sine-wave envelope by more than 125 V.

2.7 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: UL 489, with interrupting capacity to meet available fault currents.

3. Electronic trip-unit circuit breakers shall have RMS sensing; field-replaceable rating plug; and with the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I²t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
7. **GFEP Circuit Breakers**: Single- and two-pole configurations with 30-mA trip sensitivity

B. **Molded-Case Circuit-Breaker Features and Accessories**: Standard frame sizes, trip ratings, and number of poles.

1. **Lugs**: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
2. **Application Listing**: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
3. **Ground-Fault Protection**: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
4. **Communication Capability**: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 16 Section "Electrical Power Monitoring and Control."
5. **Shunt Trip**: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
6. **Undervoltage Trip**: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
7. **Auxiliary Contacts**: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
8. **Key Interlock Kit**: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
9. **Zone-Selective Interlocking**: Integral with electronic trip unit; for interlocking ground-fault protection function.
10. **Multipole units**: Enclosed in a single housing or factory-assembled to operate as a single unit.

C. **Fused Switch**: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

D. **Fuses are specified in Division 26 Section "Fuses."**

2.8 **CONTROLLERS**

A. **Motor Controllers**: NEMA ICS 2, Class A, combination controller equipped for panelboard mounting and including the following accessories:

1. Individual control-power transformers.
2. Fuses for control-power transformers.
4. Indicating lights.
5. Seal-in contact.
6. Two convertible auxiliary contacts.
7. Push buttons.
8. Selector switches.

B. **Contactors**: NEMA ICS 2, Class A, combination controller equipped for panelboard mounting and including the following accessories:

1. Individual control-power transformers.
2. Fuses for control-power transformers.
3. Indicating lights.
4. Seal-in contact.
5. Two convertible auxiliary contacts.
7. Selector switches.

C. Controller Disconnect Switches: Fused switch and interlocked with controller.
   1. Auxiliary Contacts: Integral with disconnect switches to de-energize external control-power source.

D. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held general-purpose controller.
   1. Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
   2. Control-Power Source: 120-V branch circuit.

2.9 ACCESSORY COMPONENTS AND FEATURES

A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Furnish portable test set to test functions of solid-state trip devices without removal from panelboard.

C. Fungus Proofing: Permanent fungicidal treatment for panelboard interior, including overcurrent protective devices and other components.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Mount top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated.

C. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

D. Install overcurrent protective devices and controllers.
   1. Set field-adjustable switches and circuit-breaker trip ranges.

E. Install filler plates in unused spaces.

F. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section “Electrical Identification.”

B. Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scanning of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 26 24 16
SECTION 26 27 13 - ELECTRICITY METERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes equipment for electricity metering by utility company.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Dimensioned plans and sections or elevation layouts and wiring diagrams.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Application and operating software documentation.
2. Software licenses.
3. Software service agreement.
4. Hard copies of manufacturer's operating specifications, design user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy Submittal.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

A. Meters will be furnished by utility company.

B. Current-Transformer Cabinets: Comply with requirements furnished by electrical-power utility company.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

C. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.
2. Equipment Identification Labels: Adhesive film labels with clear protective overlay.

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
2. Turn off circuits supplied by metered feeder and secure them in off condition.
3. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
4. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.

C. Electricity metering will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 26 27 13
PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid:
   1. Electrical Contractor shall provide receptacles, connectors, switches, and finish plates.

B. Alternate Bid:
   1. None.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. PVC: Polyvinyl chloride.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

D. Field quality-control test reports.

1.5 QUALITY ASSURANCE
A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70 and all appendices.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
   1. Cord and Plug Sets: Match equipment requirements.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Service/Power Poles: One for every 10, but no fewer than one.
   2. Floor Service Outlet Assemblies: One for every 10, but no fewer than one.
   3. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.
   4. TVSS Receptacles: One for every 10 of each type installed, but no fewer than two of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Wiring Devices:
      b. Eagle Electric Manufacturing Co., Inc.
      c. Hubbell Incorporated; Wiring Device-Kellems.
      d. Leviton Mfg. Company Inc.
      e. Pass & Seymour/Legrand; Wiring Devices Div.
   2. Wiring Devices for Hazardous (Classified) Locations:
      b. EGS/Appleton Electric Company.
      c. Killark Electric Manufacturing Co./Hubbell Incorporated.
3. Multioutlet Assemblies:
   a. Hubbell Incorporated; Wiring Device-Kellems.
   b. Wiremold Company (The).

4. Poke-Through, Floor Service Outlets and Telephone/Power Poles:
   a. Hubbell Incorporated; Wiring Device-Kellems.
   b. Pass & Seymour/Legrand; Wiring Devices Div.
   c. Square D/Groupe Schneider NA.
   d. Thomas & Betts Corporation.
   e. Wiremold Company (The).
   f. Thomas & Betts Corp.

2.2 RECEPTACLES

A. Straight-Blade-Type Receptacles: Comply with NEMA WD 1, NEMA WD 6, DSCC W-C-596G, and UL 498.

B. Straight-Blade and Locking Receptacles: Heavy-Duty grade.

C. GFCI Receptacles: Straight blade, non-feed-through type, Heavy-Duty grade, with integral NEMA WD 6, Configuration 5-20R duplex receptacle; complying with UL 498 and UL 493. Design units for installation in a 2-3/4-inch- (70-mm-) deep outlet box without an adapter.

D. Isolated-Ground Receptacles: Straight blade, Heavy-Duty grade, duplex receptacle, with equipment grounding contacts connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap.
   1. Devices: Listed and labeled as isolated-ground receptacles.
   2. Isolation Method: Integral to receptacle construction and not dependent on removable parts.

E. TVSS Receptacles: Straight blade, NEMA WD 6, Configuration 5-20R, with integral TVSS in line to ground, line to neutral, and neutral to ground.
   1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp level rating of 500 volts and minimum single transient pulse energy dissipation of 140 J line to neutral, and 70 J line to ground and neutral to ground.
   2. Active TVSS Indication: Visual only with light visible in face of device to indicate device is "active" or "no longer in service."
   3. Receptacle Type: Heavy-Duty grade, with isolated-ground terminal.
   4. Identification: Distinctive marking on face of device to denote TVSS-type unit.

F. Industrial Heavy-Duty Pin and Sleeve Devices: Comply with IEC 309-1.

G. Hazardous (Classified) Location Receptacles: Comply with NEMA FB 11.
2.3 PENDANT CORD/CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector, NEMA WD 6, Configurations L5-20P and L5-20R, Heavy-Duty grade.

2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.4 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.

2.5 SWITCHES


B. Snap Switches: Heavy-Duty grade, quiet type.

C. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.

2. Receptacle: NEMA WD 6, Configuration 5-15R.

D. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters.

1. Must be fully compatible with light fixture.
2. Control: Continuously adjustable slider or toggle switch; with single-pole or three-way switching to suit connections.
3. Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable rotary knob, toggle switch, or slider; single pole with soft tap or other quiet switch; EMI/RFI filter to eliminate interference; and 5-inch (130-mm) wire connecting leads.
4. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.
2.6 WALL PLATES

A. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces: 0.035-inch- (1-mm-) thick, satin-finished stainless steel.
   4. Material for Wet Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

2.7 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
B. Compartments: Barrier separates power from voice and data communication cabling.
C. Service Plate: Rectangular, solid brass with satin finish.
D. Power Receptacle: NEMA WD 6, Configuration 5-20R, finish to match others, unless otherwise indicated.
E. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 Category 5 jacks for UTP cable.

2.8 MULTIOUTLET ASSEMBLIES

A. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
B. Raceway Material: Metal, with manufacturer's standard finish.
C. Wire: No. 12 AWG.

2.9 SERVICE POLES

A. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
   1. Poles: Nominal 2.5-inch- (65-mm-) square cross section, with height adequate to extend from floor to at least 6 inches (150 mm) above ceiling, and with separate channels for power wiring and voice and data communication cabling.
   2. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
   3. Finishes: Manufacturer's standard painted finish and trim combination.
   4. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors; and a minimum of four, 4-pair, Category 5 voice and data communication cables.
5. Power Receptacles: Two duplex, 20-A, heavy-duty, NEMA WD 6, Configuration 5-20R units.

2.10 FINISHES

A. Color:
   1. Wiring Devices Connected to Normal Power System: White, unless otherwise indicated or required by NFPA 70.
   3. TVSS Devices: Blue.
   4. Isolated-Ground Receptacles: As specified above, with orange triangle on face.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices and assemblies level, plumb, and square with building lines.
B. Install wall dimmers to achieve indicated rating after derating for ganging according to manufacturer's written instructions.
C. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' written instructions.
D. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
E. Remove wall plates and protect devices and assemblies during painting.
F. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.
G. Install barriers in switch boxes if 480 VAC is present.

3.2 IDENTIFICATION

A. Comply with Division 16 Section "Electrical Identification."
   1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 CONNECTIONS
A. Ground equipment according to Division 16 Section "Grounding and Bonding."

B. Connect wiring according to Division 16 Section "Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 26 27 26
SECTION 26 43 13 - SURGE PROTECTION FOR
LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.
   B. Sample Warranty: For manufacturer's special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL SPD REQUIREMENTS

A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with NFPA 70.
C. Comply with UL 1449.
D. MCOV of the SPD shall be the nominal system voltage.

2.2 SERVICE ENTRANCE SUPPRESSOR
A. Manufacturer shall match service entrance equipment.
B. SPDs: Comply with UL 1449, Type 1.
   1. SPDs with the following features and accessories:
      a. Integral disconnect switch.
      b. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
      c. Indicator light display for protection status.
C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 240kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
D. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
   1. Line to Neutral: 700 V for 208Y/120 V.
   2. Line to Ground: 1200 V for 208Y/120 V.
   3. Line to Line: 1000 V for 208Y/120 V.
E. SCCR: Equal or exceed 100 kA.
F. In nominal Rating: 20 kA.

2.3 PANEL SUPPRESSORS
A. Manufacturer shall match panelboard.
B. SPDs: Comply with UL 1449, Type 1.
   1. Include LED indicator lights for power and protection status.
   2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
D. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V for 208Y/120 V.
2. Line to Ground: 700 V for 208Y/120 V.
3. Neutral to Ground: 700 V for 208Y/120 V.
4. Line to Line: 1200 V for 208Y/120 V.

E. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: 700 V.
3. Neutral to Ground: 700 V.
4. Line to Line: 1200 V.

F. SCCR: Equal or exceed 100 kA.

G. Innominal Rating: 20 kA.

2.4 ENCLOSURES

A. Indoor Enclosures: NEMA 250, Type 1.

B. Outdoor Enclosures: NEMA 250, Type 3R.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

D. Use crimped connectors and splices only. Wire nuts are unacceptable.

E. Complete startup checks according to manufacturer's written instructions. Energize SPDs after power system has been energized, stabilized, and tested.
3.2 FIELD QUALITY CONTROL
   A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
      1. Compare equipment nameplate data for compliance with Drawings and Specifications.
      2. Inspect anchorage, alignment, grounding, and clearances.
      3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
   B. An SPD will be considered defective if it does not pass tests and inspections.
   C. Prepare test and inspection reports.

3.3 DEMONSTRATION
   A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 26 43 13
SECTION 26 51 16 - FLUORESCENT INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Interior fluorescent luminaires, lamps, and ballasts.
   2. Luminaire supports.

B. Related Requirements:
   1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
   2. Section 260926 "Lighting Control Panelboards" for panelboards used for lighting control.
   3. Section 260936.19 "Standalone Multipreset Modular Dimming Controls" for architectural dimming systems and for fluorescent dimming controls with dimming.
   4. Section 260943.23 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating

E. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, arranged by designation.

B. Shop Drawings: For nonstandard or custom luminaires.
   1. Include plans, elevations, sections, and mounting and attachment details.
   2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

C. LEED Submittals:
1. Product Data for Credit IEQ 4.2: For paints and coatings, documentation including printed statement of VOC content.

D. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of ballast for bi-level and dimmer-controlled luminaires, from manufacturer.

B. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. UL Compliance: Comply with UL 1598.

E. Nominal Operating Voltage: 120 V ac.

F. Recessed Luminaires: Comply with NEMA LE 4.

2.2 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. General Requirements for Electronic Ballasts:
1. Comply with UL 935 and with ANSI C82.11.
2. Designed for type and quantity of lamps served.
3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
4. Sound Rating: Class A.
5. THD Rating: Less than 10 percent.
6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
7. Operating Frequency: 42 kHz or higher.

B. Single Ballasts for Multiple Luminaires: Factory wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.

C. Ballasts for Dimmer-Controlled Luminaires: Electronic type.
   1. Dimming Range: 100 to 5 percent of rated lamp lumens.
   2. Ballast Input Watts: Can be reduced to 20 percent of normal.
   3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

D. Ballasts for Bi-Level Controlled Luminaires: Electronic type.
   1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level operation and off.
      a. High-Level Operation: 100 percent of rated lamp lumens.
      b. Low-Level Operation: 30 percent of rated lamp lumens.
   2. Ballast shall provide equal current to each lamp in each operating mode.
   3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

E. Ballasts for Tri-Level Controlled Luminaires: Electronic type.
   1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level operation and off.
      a. High-Level Operation: 100 percent of rated lamp lumens.
      b. Low-Level Operation: 30 and 50 percent of rated lamp lumens.
   2. Ballast shall provide equal current to each lamp in each operating mode.
   3. Compatibility: Certified by manufacturer for use with specific tri-level control system and lamp type indicated.

2.3 EMERGENCY FLUORESCENT POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with ballast. Comply with UL 924.
1. Emergency Connection: Operate one fluorescent lamp continuously at an output of 1400 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.

2. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

B. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more fluorescent lamps, remote mounted from luminaire. Comply with UL 924.

1. Emergency Connection: Operate one fluorescent lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.

2. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.4 FLUORESCENT LAMPS

A. T8 rapid-start lamps, rated 32-W maximum, nominal length of 48 inches (1220 mm), 2800 initial lumens (minimum), CRI of 75 (minimum), color temperature of 3500 K, and average rated life of 20,000 hours unless otherwise indicated.

B. T8 rapid-start lamps, rated 17-W maximum, nominal length of 24 inches (610 mm), 1300 initial lumens (minimum), CRI of 75 (minimum), color temperature of 3500 K, and average rated life of 20,000 hours unless otherwise indicated.

C. T5 rapid-start lamps, rated 28-W maximum, nominal length of 45.2 inches (1150 mm), 2900 initial lumens (minimum), CRI of 85 (minimum), color temperature of 3500 K, and average rated life of 20,000 hours unless otherwise indicated.

D. T5HO rapid-start, high-output lamps, rated 54-W maximum, nominal length of 45.2 inches (1150 mm), 5000 initial lumens (minimum), CRI of 85 (minimum), color temperature of 3500 K, and average rated life of 20,000 hours unless otherwise indicated.

2.5 CYLINDER

A. With integral mounting provisions.

2.6 DOWNLIGHT

A. Universal mounting bracket.

B. Integral junction box with conduit fittings.
2.7 PARKING GARAGE
   A. Low-profile housing and heat sink.
   B. Fully gasketed and sealed. [IP 65 rated.]
   C. Stainless-steel latches.
   D. Integral pressure equalizer.

2.8 RECESSED LINEAR
   A. Integral junction box with conduit fittings.

2.9 STRIP LIGHT
   A. Integral junction box with conduit fittings.

2.10 SURFACE MOUNT, LINEAR
   A. Universal mounting bracket.
   B. Integral junction box with conduit fittings.

2.11 SURFACE MOUNT, NONLINEAR
   A. Universal mounting bracket.
   B. Integral junction box with conduit fittings.

2.12 SUSPENDED, LINEAR
   A. Ceiling mounted with [two] <Insert number> 5/32-inch- (4-mm-) <Insert value> diameter aircraft cable supports [adjustable to] [120 inches (6 m)] <Insert value> in length.

2.13 SUSPENDED, NONLINEAR
   A. Universal mounting bracket.
   B. Integral junction box with conduit fittings.

2.14 MATERIALS
   A. Metal Parts:
1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:
   1. Prismatic glass or clear, UV-stabilized acrylic.
   2. Glass: Annealed crystal glass unless otherwise indicated.
   3. Acrylic: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   4. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

D. Housings:
   1. Extruded-aluminum housing and heat sink.
   2. [Clear] <Insert color> [anodized] [powder-coat] [painted] finish.

2.15 METAL FINISHES
   A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.16 LUMINAIRE SUPPORT COMPONENTS
   A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
   B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish shall match luminaire.
   C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).
   D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
   E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Remote Mounting of Ballasts: Distance between the ballast and luminaire shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.

C. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

D. Install lamps in each luminaire.

E. Supports: Sized and rated for luminaire weight.

F. Ceiling-Grid-Mounted Luminaire Supports:
   1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each luminaire. Locate not more than 6 inches (150 mm) from luminaire corners.
   2. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for the application.
   3. Luminaires of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
   4. Install at least two independent support rods or wires from structure to a tab on luminaire. Wire or rod shall have breaking strength of the luminaire weight at a safety factor of 3.

G. Flush-Mounted Luminaire Support:
   1. Secured to outlet box.
   2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
   3. Trim ring flush with finished surface.

H. Wall-Mounted Luminaire Support:
   1. Attached to a minimum 20 gauge backing plate attached to wall structural members.
   2. Do not attach luminaires directly to gypsum board.

I. Suspended Luminaire Support:
   1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod or wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

K. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 26 51 16
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Interior solid-state luminaires that use LED technology.
   2. Lighting fixture supports.

B. Related Requirements:
   1. Section 26 09 23 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
   2. Section 26 09 43.23 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Arrange in order of luminaire designation.
   2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project, IES LM-79, and IES LM-80.

   a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
   b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

B. Shop Drawings: For nonstandard or custom luminaires.

   1. Include plans, elevations, sections, and mounting and attachment details.
   2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

   1. Lighting luminaires.
   2. Suspended ceiling components.
   3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches (300 mm) of the plane of the luminaires.
   4. Structural members to which equipment and luminaires will be attached.
   5. Initial access modules for acoustical tile, including size and locations.
   6. Items penetrating finished ceiling, including the following:

       a. Other luminaires.
       b. Air outlets and inlets.
       c. Speakers.
       d. Sprinklers.
       e. Access panels.
       f. Ceiling-mounted projectors.

   7. Moldings.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.
C. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

D. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Product Certificates: For each type of luminaire.

F. Product Test Reports: For each luminaire, for tests performed by a qualified testing agency.

G. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
   2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
   3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.
D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY
A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
   1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 LUMINAIRE REQUIREMENTS
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
D. Recessed Fixtures: Comply with NEMA LE 4.
E. Bulb shape complying with ANSI C79.1.
F. Lamp base complying with ANSI C81.61.
G. CRI of minimum 80. CCT of 3000 K.
H. Rated lamp life of minimum 50,000 hours.

I. Lamps dimmable from 100 percent to 0 percent of maximum light output.

J. Internal driver.

K. Nominal Operating Voltage: 120 V ac.
   1. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

L. Housings:
   1. Extruded-aluminum housing and heat sink.
   2. Painted finish.

2.3 CYLINDER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

B. Minimum allowable efficacy of 80 lumens per watt.

C. With integral mounting provisions.

D. Refer to Lighting Fixture Schedule.

2.4 DOWNLIGHT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

B. Minimum allowable efficacy of 80 lumens per watt.

C. Universal mounting bracket.

D. Integral junction box with conduit fittings.

E. Refer to Lighting Fixture Schedule.

2.5 LINEAR INDUSTRIAL

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

B. Minimum allowable efficacy of 80 lumens per watt.

C. Refer to Lighting Fixture Schedule.
2.6 RECESSED LINEAR
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   B. Minimum allowable efficacy of 85 lumens per watt.
   C. Integral junction box with conduit fittings.
   D. Refer to Lighting Fixture Schedule.

2.7 STRIP LIGHT
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   B. Minimum allowable efficacy of 80 lumens per watt.
   C. Integral junction box with conduit fittings.
   D. Refer to Lighting Fixture Schedule.

2.8 SUSPENDED, LINEAR
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   B. Minimum allowable efficacy of 85 lumens per watt.
   C. Refer to Lighting Fixture Schedule.

2.9 SUSPENDED, NONLINEAR
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   B. Minimum allowable efficacy of 85 lumens per watt.
   C. Integral junction box with conduit fittings.
   D. Refer to Lighting Fixture Schedule.

2.10 MATERIALS
   A. Metal Parts:
      1. Free of burrs and sharp corners and edges.
2.   Sheet metal components shall be steel unless otherwise indicated.
3.   Form and support to prevent warping and sagging.

B.   Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C.   Diffusers and Globes:
1.   Type per fixture. Refer to Lighting Fixture Schedule.
2.   Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3.   Glass: Annealed crystal glass unless otherwise indicated.
4.   Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

D.   Housings:
1.   Extruded-aluminum housing and heat sink.
2.   Painted finish.

E.   Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1.   Label shall include the following lamp characteristics:
   a.   "USE ONLY" and include specific lamp type.
   b.   Lamp diameter, shape, size, wattage, and coating.
   c.   CCT and CRI for all luminaires.

2.11   METAL FINISHES

A.   Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.12   LUMINAIRE FIXTURE SUPPORT COMPONENTS

A.   Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B.   Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C.   Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

D.   Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:
   1. Sized and rated for luminaire weight.
   2. Able to maintain luminaire position after cleaning and relamping.
   3. Provide support for luminaire without causing deflection of ceiling or wall.
   4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaire Support:
   1. Secured to outlet box.
   2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
   3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaire Support:
   1. Attached using through bolts and backing plates on either side of wall.
   2. Do not attach luminaires directly to gypsum board.
G. Ceiling-Mounted Luminaire Support:
   1. Ceiling mount with two 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 36 inches (1 m) in length.

H. Suspended Luminaire Support:
   1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
   3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
   4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

I. Ceiling-Grid-Mounted Luminaires:
   1. Secure to any required outlet box.
   2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
   3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

J. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION
A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL
A. Perform the following tests and inspections:
   1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
   2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.
3.6 STARTUP SERVICE

A. Comply with requirements for startup specified in Section 26 09 43.16 "Addressable-Fixture Lighting Controls."

B. Comply with requirements for startup specified in Section 26 09 43.23 "Relay-Based Lighting Controls."

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 26 51 19
SECTION 26 52 19 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Exit signs.
   2. Luminaire supports.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.
B. CRI: Color Rendering Index.
C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
D. Fixture: See "Luminaire" Paragraph.
E. Lumen: Measured output of lamp and luminaire, or both.
F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of exit sign and emergency lighting support.
   1. Include data on features, accessories, and finishes.
   2. Include physical description of the unit and dimensions.
   3. Battery and charger for light units.
   4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
   5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
      a. Testing Agency Certified Data: For indicated signs, photometric data certified by a qualified independent testing agency. Photometric data for remaining signs shall be certified by manufacturer.
b. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom luminaires.
   1. Include plans, elevations, sections, and mounting and attachment details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

C. Samples: For each product and for each color and texture specified.

D. Samples for Initial Selection: For each type of luminaire with factory-applied finishes.

E. Samples for Verification: For each type of luminaire.
   1. Include Samples of luminaires and accessories to verify finish selection.

F. Product Schedule:
   1. For exit signs. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Luminaires.
   2. Suspended ceiling components.
   3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches (300 mm) of the plane of the luminaires.
   4. Structural members to which equipment will be attached.
   5. Size and location of initial access modules for acoustical tile.
   6. Items penetrating finished ceiling including the following:
      a. Other luminaires.
      b. Air outlets and inlets.
      c. Speakers.
      d. Ceiling-mounted projectors.
      e. Sprinklers.
      f. Access panels.
   7. Moldings.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.
C. Product Certificates: For each type of luminaire.

D. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Product Test Reports: For each luminaire for tests performed by a qualified testing agency.

F. Sample Warranty: For manufacturer's warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Luminaire-mounted, emergency battery pack: One for every 20 emergency lighting units. Furnish at least one of each type.
   2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
   3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.
   1. Obtain Architect's approval of luminaires and signs in mockups before starting installations.
   2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING
   A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY
   A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
      1. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
      1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.
C. Comply with NFPA 70 and NFPA 101.

D. Comply with NEMA LE 4 for recessed luminaires.

2.3 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
2. Operating at nominal voltage of 120 V ac.
3. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
4. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.
5. Master/Remote Sign Configurations:
   a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in battery for power connection to remote unit.
   b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.4 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Clear, UV-stabilized acrylic.
2. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

D. Housings:
1. Extruded aluminum housing and heat sink.
2. Painted finish.

E. Conduit: Electrical metallic tubing, minimum 3/4 inch (21 mm) in diameter.

2.5 METAL FINISHES

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position when testing emergency power unit.
3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.

E. Wall-Mounted Luminaire Support:
   1. Attached using through bolts and backing plates on either side of wall.
   2. Do not attach luminaires directly to gypsum board.

F. Ceiling Grid Mounted Luminaires:
   1. Secure to any required outlet box.
   2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
   3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION
   A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL
   A. Perform the following tests and inspections:
      1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
   B. Luminaire will be considered defective if it does not pass operation tests and inspections.
   C. Prepare test and inspection reports.

3.5 STARTUP SERVICE
   A. Perform startup service:
      1. Charge batteries minimum of one hour and depress switch to conduct short-duration test.
      2. Charge batteries minimum of 24 hours and conduct one-hour discharge test.

3.6 ADJUSTING
   A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:
1. Inspect all luminaires. Replace lamps, batteries, signs, or luminaires that are defective.
   a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

2. Conduct short-duration tests on all emergency lighting.

END OF SECTION 26 52 19
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
   2. Luminaire supports.
   3. Luminaire-mounted photoelectric relays.

B. Related Requirements:
   1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
   2. Section 260926 "Lighting Control Panelboards" for panelboard-based lighting control.
   3. Section 260943.16 "Addressable-Fixture Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.
   4. Section 265613 "Lighting Poles and Standards" for poles and standards used to support exterior lighting equipment.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.

B. Shop Drawings: For nonstandard or custom luminaires.
   1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. LEED Submittals:

1. Product Data for Credit EA 5: For specified metering equipment.
2. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale and coordinated.

B. Product Certificates: For each type of the following:

1. Luminaire.
2. Photoelectric relay.

C. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

1.6 FIELD CONDITIONS

A. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.7 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 2 year(s) from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. UL Compliance: Comply with UL 1598 and listed for wet location.

E. Lamp base complying with ANSI C81.61 or IEC 60061-1.

F. CRI of minimum 70. CCT of 4100 K.

G. L70 lamp life of 50,000 hours.

H. Lamps dimmable from 100 percent to 0 percent of maximum light output.

I. Nominal Operating Voltage: 120 V ac.

J. In-line Fusing: Separate in-line fuse for each luminaire.

K. Lamp Rating: Lamp marked for outdoor use and in enclosed locations.

L. Source Limitations: Obtain luminaires from single source from a single manufacturer.

M. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 LUMINAIRE TYPES

A. Area and Site:

1. Luminaire Shape: [Round] [Square] [Hexagonal] <Insert shape or feature>.

2. Mounting: [Pole] [Building] <Insert mounting type> with [extruded-aluminum] [stainless-steel] <Insert material> [rectangular] [round] arm, [11 inches (280 mm)][13 inches (330 mm)] in length.

3. Luminaire-Mounting Height: <Insert height of luminaire from finished grade>.

4. Distribution: [Type I] [Type II] [Type III] [Type IV] [Type V].

B. Canopy:

1. Shape: [Round] [Square] <Insert shape>.
2. Dimensions: [12 inches (300 mm)] [square] [in diameter].

C. Decorative Post Top:
   1. Luminaire-Mounting Height: <Insert height of luminaire from finished grade>.
   2. Mounting Type: [Arm] [Tenon] [Ring].
   3. Distribution: [Type I] [Type II] [Type III] [Type IV] [Type V].

2.3 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Corrosion-resistant aluminum. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

D. Diffusers and Globes:
   1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   2. Glass: Annealed crystal glass unless otherwise indicated.
   3. Lens Thickness: At least 0.125 inch ((3.175 mm)) minimum unless otherwise indicated.

E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.

G. Housings:
   1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
   2. Provide filter/breather for enclosed luminaires.

2.4 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.
   a. Color: [Light bronze] [Medium bronze] [Dark bronze] [Black] <Insert color>.

D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
   a. Color: As selected from manufacturer's standard catalog of colors.
   c. Color: As selected by Architect from manufacturer's full range.

2.5 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Install lamps in each luminaire.

D. Fasten luminaire to structural support.

E. Supports:
   1. Sized and rated for luminaire weight.
   2. Able to maintain luminaire position after cleaning and relamping.
   3. Support luminaires without causing deflection of finished surface.
   4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

F. Wall-Mounted Luminaire Support:
   1. Attached to a minimum 1/8 inch (3 mm) backing plate attached to wall structural members.


H. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at height and aiming angle as indicated on Drawings.

I. Coordinate layout and installation of luminaires with other construction.

J. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.2 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

A. Aim as indicated on Drawings.

B. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."
3.3  CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.4  IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5  FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

2. Verify operation of photoelectric controls.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):

   a. IES LM-5.
   b. IES LM-50.
   c. IES LM-52.
   d. IES LM-64.
   e. IES LM-72.

2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

D. Luminaire will be considered defective if it does not pass tests and inspections.

E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.
3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaires.

END OF SECTION 26 56 19
PART 1 - GENERAL

1.1 SPECIAL NOTE

A. All provisions of the Bidding Requirements, General Conditions and Supplementary Conditions, including Division 00 and Division 01, apply to work specified in this Division.

B. The scope of the Division 27 work includes furnishing, installing, testing and warranty of all work and complete Communication systems as shown on the T Series drawings, and as specified in Division 27 and elsewhere in the project documents.

C. Understanding that the contractors for various Divisions are sub-contractors Construction Manager at Risk, assignments of work by division are not intended to restrict the Construction Manager at Risk in assignment of work among the contractors to accommodate trade agreements and practices or the normal conduct of the construction work. If there is a conflict of assigned work between Divisions 02 thru 33 and Divisions 00 and 01, Divisions 00 and 01 shall take precedence.

1.2 PERMITS AND REGULATIONS

A. Include payment of all permit and inspection fees applicable to the Division 27 work. Furnish for the Owner certificates of approval from the governing inspection agencies, as a condition for final payment.

B. Work must conform to the National Electrical Code, National Electrical Safety Code and other applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawings and specifications shall govern. Install no work contrary to minimum legal standards.

C. All electrical work shall be inspected and approved by the local jurisdictional authority.

1.3 INSPECTION OF SITE

A. Inspect the project site. Conditions shall be compared with information shown on the drawings. Report immediately to the Architect \ Construction Manager any significant discrepancies which may be discovered. After the contract is signed, no allowance will be made for failure to have made a thorough inspection.

1.4 ALTERNATES

A. Alternate T-1. Emergency Radio Responder Coverage System ADD ALTERNATE

Base Bid work does not include the ERRCS (section 28 31 13) as shown on the drawings and specifications.

Alternate includes providing the complete ERRCS (28 31 13) as indicated on the drawings and specifications

B. Refer to the description of Alternates in Division 01 which affect the Division 27 work.
1.5 DRAWINGS AND SPECIFICATIONS

A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word "provide", as used, shall mean "furnish and install". If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect / Construction Manager for approval before proceeding with the work.

B. Make all necessary field measurements to ensure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.

C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect / Construction Manager for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having wireways and fittings fabricated and delivered in advance of making actual measurements shall not be sufficient cause to avoid making offsets and minor changes as may be necessary to install wireways, fittings and equipment.

1. Where there are quantity discrepancies of equipment shown on drawings and/or specifications, the Contractor shall provide the greater quantity.

D. The Architect / Construction Manager shall reserve the right to make minor adjustment in locations of system runs and components where he considers such adjustments desirable in the interest of protecting and concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

E. Equipment, ductwork, piping and communications wiring shall not be installed in the dedicated electrical space above or in the working space required around electrical switchgear, motor control centers or panelboards as identified by NEC 110.26 Spaces About Electrical Equipment – 600 Volts Nominal or Less. For equipment rated over 600 volts nominal – 110.32 Work Space About Equipment – 110.33 Entrance and Access to Work Space – 110.34 Work Space and Guarding. Caution other trades to comply with this stipulation.

F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect's / Construction Manager’s decision shall be final in regard to the arrangement of conduit, etc., where conflict arises.

G. Provide offsets in system runs, additional fittings, necessary conduit, pull boxes, conductors, switches and devices required to complete the installation, or for the proper operation of the system. Exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.

H. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect / Construction Manager. In such event, none of the trades or their suppliers shall assume that he is relieved of the work which is specified under his branch until instructions in writing are received from the Architect / Construction Manager.
1.6 INSPECTION

A. All work shall be subject to inspection of Federal, State and local agencies as may be appropriate, and of the Architect and Engineer.

B. Obtain final inspection certificates and turn over to the Owner.

1.7 RECORD DRAWINGS

A. Maintain a separate set of field prints of the contract documents and show all changes or variations, in a manner to be clearly discernible, which are made during construction. Upon completion of the work and within 90 days of system acceptance, these drawings shall be turned over to the Architect / Construction Manager. This shall apply particularly to underground and concealed work, and to other systems where the installation varies to a degree which would justify recording the change.

1.8 OPERATING AND MAINTENANCE MANUALS

A. Assemble two copies each of operating and maintenance manuals for the Communications work.

B. All “approved” shop drawings and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list, and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, prepare and include a chart listing all items of equipment which are furnished under this contract, indicating the nature of maintenance required, the recommended frequency of checking these points and the type of replacement material required. Name and address of a qualified service agency.

C. Standard NEMA publications on the operation and care of equipment may be furnished in lieu of manufacturer's data where the manufacturer's instructions are not available.

D. Original purchase order number, date of purchase, name, address, and phone number of the vendor warranty information.

E. Copy of required test reports.

F. These shall be assembled into three-ring loose leaf binders or other appropriate binding. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to the Engineer and / Construction Manager for review. Upon approval, manuals shall be turned over to the Owner.

G. O&M Manuals shall contain the following information at a minimum:

1. Copies of all approved shop drawings with the Engineer’s stamp.
2. Owner’s manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner’s manuals. CDs containing
electronic versions of Owner’s manuals must contain the proper software viewers for each document type.

3. Communications drawings updated with final as-built information. This shall be in the form of a complete set of Communications drawings with as-built information indicated in colored pen based upon actual field conditions.

4. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

5. Rack elevations for all systems with rack mounted equipment.

1.9 FINAL INSPECTION AND PUNCH LIST

A. As the time of work completion approaches, survey and inspect Division 27 work and develop a punch list to confirm that it is complete and finished. Then notify the Architect and Construction Manager and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected the work and so states at the time of the request for the final inspection.

B. Requests to the Architect, Engineer or Construction Manager for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and schedule for completing these; this is in the interest of expediting acceptance for beneficial occupancy.

C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion or verification. Corrective action shall be taken by the Contractor to the satisfaction of Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.10 WARRANTY

A. Warrant all workmanship, equipment and material entering into this contract for a period of one (1) year or the period of time as per specific specification section, from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. The use of equipment for temporary communication systems is not the start of the warranty period.

B. This provision is intended specifically to cover deficiencies in contract completion or performance which are not immediately discovered after systems are placed in operation. These items include, but are not limited to replacement of malfunctioning equipment and adjusting special equipment and communication systems to obtain optimum performance.

C. This provision shall not be construed to include maintenance items such as making normally anticipated adjustments or correcting adjustment errors on the part of the Owner's personnel.

D. Provisions of this warranty shall be considered supplementary to warranty provisions under Division 01 General Conditions.
PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment furnished shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.

B. All electrical equipment and wiring shall bear the Underwriters Laboratories, Inc. label where UL labeled items are available, and shall comply with NEC (NFPA-70) and NFPA requirements.

2.2 REFERENCE STANDARDS

A. Where standards (NFPA, NEC, EIA/TIA, ASTM, UL, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the Authority Having Jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

2.3 EQUIPMENT SELECTION

A. The selection of materials and equipment to be furnished shall be governed by the following:

1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specification, the exact equipment listed shall be furnished. Where more than one name is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturers listed.

2. Where the words "or approved equal" appear after a manufacturer's name, specific approval must be obtained from the Engineer during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.

3. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.

B. Substitute equipment of equal quality and capacity will be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.

C. Before bidding equipment, and again in the preparation of shop drawings, verify that adequate space is available for entry and installation of the item of equipment, including associated accessories. Also verify that adequate space is available for servicing of the equipment and that required NEC clearances are met.

D. If extensive changes in conduit, equipment layout or electrical wiring and equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in this contract.
2.4 SHOP DRAWINGS

A. Electronic copies of shop drawings and descriptive information of equipment and materials shall be furnished. Submit to the Architect and/or Engineer for review as stated in the General Conditions and Supplementary Conditions. These shall be submitted as soon as practicable and before equipment is installed and before special equipment is manufactured. Submittal information shall clearly identify the manufacturer, specific model number, approval labels, performance data, pump curves, electrical characteristics, features, specified options and additional information sufficient to evidence compliance with the contract documents. Product catalogs, brochures, etc. submitted without project specific items marked as being submitted for review will be rejected and returned without review. Shop drawings for equipment, fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. If compliance with the above criteria is not provided shop drawings will be subject to rejection and returned without review. Samples shall be submitted when requested or as specified here with-in.

B. The review of shop drawings by the Architect or Engineer shall not relieve the Contractor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer's attention in a separate clearly stated notification at the time of submittal for the Engineer's review.

C. Electronic format – Shop drawings may be submitted in electronic format utilizing PDF files. The submittal shall be organized by specification section and contain all required information within a PDF document for each specification section. The submittal shall be organized as follows:

   1. Primary zip file contains a PDF of master transmittal cover page indicating the project name, submitting contractor, contact information and a list of all the sections with titles being submitted. This primary file shall also contain each of the individual PDF files for the individual sections being submitted.

   2. Sub PDF file for each specification section organized as follows:
      a. First page - Cover page indicating the project name, submitting contractor, contact information, space for Engineer’s stamp.
      b. Page(s) for contractor qualifications and project certifications.
      c. Page(s) for Bill of Materials (BOM) list including part numbers, quantities and references to specification section paragraphs for each part.
      d. Page(s) for manufacturer’s data sheets.
      e. Page(s)/Drawing(s) for system diagrams, riser diagrams, block diagrams, etc.
      f. Drawing(s) for floor plans showing equipment locations.

D. Refer to individual system specifications for submittal requirements. At a minimum, shop drawings shall contain the following information:

   1. A complete list of materials with model and part numbers and reference to the Part 2 specification paragraph number.
   2. Shop drawings including manufacturer’s product and cable data sheets specific to the project. Data sheets shall indicate exact model numbers and options specific to the project.
   3. Floor plans showing location of all items of equipment. Drawings shall also indicate each location where 120VAC power is required.
4. Job specific schematic and point to point wiring diagrams showing all devices, number and size of wires, etc.
5. Contractor qualifications and/or Manufacturer’s Certifications where specifically specified.
6. System software information, where applicable showing features, version, hardware requirements, and any other information required to ascertain conformance with specifications.

E. Equipment that does not fully comply with the specifications and which has not had this information presented in the shop drawing phase and approved, will be removed and replaced with specification compliant equipment at the contractor’s expense.

F. Any shop drawings that do not contain the minimum required information outlined herein and as specified elsewhere shall be considered incomplete and will not be reviewed. It is the contractor’s responsibility to fully read and understand all requirements for submittals for each section and to carefully and completely adhere to all requirements.

2.5 COMPUTER WORKSTATIONS

A. All computer workstations provided under this contract shall utilize the same manufacturers chipsets, hardware and peripherals. All processors shall be either Intel or AMD. It shall also be required to provide the same manufacturer for monitors, keyboards, mice, video cards, etc. Refer to specs in each section for specific requirements such as processor speed and base memory.

B. All computer workstations provided under this contract shall be equipped with fully licensed, automated, active anti-virus software. Approved anti-virus software packages shall be as produced by Norton, McAfee or Symantec.

C. All computer workstations provided under this contract shall be provided with two USB 2.0 ports and an Ethernet NIC.

PART 3 - EXECUTION

3.1 TESTING

A. As each wiring system is completed, it shall be tested for continuity and freedom from grounds.

B. As each electrically operated system is energized, it shall be tested for function.

C. The Contractor shall perform megger and resistance tests and special tests on any circuits or equipment when an authorized inspection agency suspects the system's integrity or when requested by the Architect or Engineer.

D. All signaling and communications systems shall be inspected and tested by a qualified representative of the manufacturer or equipment vendor. Refer to specific sections for required testing of the various systems. Submit four (4) copies of reports indicating results.

E. Tests shall be witnessed by field representatives of the Architect or Engineer or shall be monitored by a recorder. Furnish a written record of each system test indicating date, system,
test conditions, duration and results of tests. Copies of all test reports shall be included in the O&M manuals.

F. Instruments required for tests shall be furnished by the Contractor.

3.2 EQUIPMENT CLEANING

A. Before placing each system in operation, the equipment shall be thoroughly cleaned; cleaning shall be performed in accordance with equipment manufacturer’s recommendations.

B. Refer to appropriate Sections for cleaning of other equipment and systems for normal operation.

3.3 OPERATION AND ADJUSTMENT OF EQUIPMENT

A. As each system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing and adjusting voltages and currents; verifying phase rotation; setting breakers, ground fault and other relays, controllers, meters and timers; and adjusting all operating equipment.

3.4 OPERATING DEMONSTRATION AND INSTRUCTIONS

A. Set the various systems into operation and demonstrate to the Owner and Architect / Engineer / Construction Manager that the systems function properly and that the requirements of the Contract are fulfilled.

B. Provide the Owner’s representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.

C. O & M Manuals shall be submitted, reviewed and approved prior to scheduling of demonstrations.

D. A minimum of 24 hours shall be allowed for instruction to personnel selected by the Owner. Instructions shall include not less than the following:

1. Show location of items of equipment and their purpose.
2. Review binder containing instructions and equipment and systems data.
3. Coordinate written and verbal instructions so that each is understood by personnel.
4. Manufacturer’s representatives for the various special and communication systems shall give separate instructions.
5. All operating demonstrations and instructions for each system shall be audio/video digitally recorded and turned over to the Owner.

E. A minimum of 48 hours continuous trouble-free operating time shall be acceptable to prove that the systems function properly.
F. Note that additional time for training, operating time, etc. may be required per other specification sections and shall be included. This section only establishes minimum requirements.

END OF SECTION 270501
SECTION 270502 - AGREEMENT AND WAIVER FOR USE OF ELECTRONIC FILES

PART 1 - GENERAL

1.1 The Engineer, at his sole discretion and without obligation, makes graphic portions of the contract documents available for use by the contractor in electronic format. These electronic files are proprietary, and remain the Engineer’s Instruments of Service and shall be for use solely with respect to this project, as provided in the Standard Form of Agreement between Owner/Architect and Engineer.

1.2 Electronic files shall be released only after bids have been received for the project and contracts have been signed with the contractors.

1.3 The contractor shall acknowledge receipt of electronic files in the requested format for this project. The electronic files are provided as a convenience to the User, for use in preparing shop drawings and/or coordination drawings related to the construction of only the project identified in the Agreement. The electronic files and the information contained within are the property of the Engineer and/or the Architect and/or the Owner, and may not be reproduced or used in any format except in conjunction with the project identified in the Agreement.

1.4 The User acknowledges that the information provided in the electronic files is not a substitution or replacement for the Contract Documents and does not become a Contract Document. The User acknowledges that neither the Engineer, the Architect, the Consultants, the Client or the Owner make any warrant or representation that the information contained in the electronic files reflect the Contract Documents in their entirety. The User assumes full responsibility in the use of the electronic files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

1.5 The User acknowledges that the receipt of electronic files in no way relieves the User from the responsibility for the preparation of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

1.6 Electronic files are available in the AutoCAD .DWG or Revit model format for a cost as indicated in the Agreement and Waiver Form. Providing the documents in the .DXF format will be an additional charge per sheet as indicated in the Agreement and Waiver Form. Charges are for the Engineer’s time to prepare the documents in the format stated. They are available through the Engineer’s office on a C.O.D. basis only. A sample of the format will be provided by the Engineer upon request by the contractor, for the purpose of testing the compatibility of the format to contractor’s systems.

1.7 Projects developed using AutoCAD MEP will have all drawings converted to the AutoCAD format, when requested to be DWG or DXF format.

1.8 Project models will be furnished without views.

1.9 The electronic files shall be stripped of the Project’s name and address, the Architect’s / and / Engineer’s / and / any consultant’s name and address, and any professional licenses indicated on the contract documents, (and all dimensions, verbiage, and statistical information). Use of these electronic files is solely at the contractor’s risk, and shall in no way alter the contractor’s Contract for Construction.
1.10 The User agrees to indemnify, hold harmless and defend the Engineer, the Architect, the Consultants, the Owner, the Client and any of their agents from any litigation resulting from the use of (by any means of reproduction or electronic media) these files. The Engineer makes no representation regarding fitness for any particular purpose, or suitability for use with any software or hardware, and shall not be responsible or liable for errors, defects, inexactitudes, or anomalies in the data, information, or documents (including drawings and specifications) caused by the Engineer’s or its consultant’s computer software or hardware defects or errors; the Engineer’s or its consultant’s electronic or disk transmittal of data, information or documents; or the Engineer’s or its consultant’s reformatting or automated conversion of data, information or documents electronically or disk transmitted from the Engineer’s consultants to the Engineer.

1.11 The contractor waives all claims against the Engineer, its employees, officers and consultants for any and all damages, losses, or expenses the contractor incurs from such defects or errors in the electronic files. Furthermore, the contractor shall indemnify, defend, and hold harmless the Engineer, and its consultants together with their respective employees and officers, harmless from and against any claims, suits, demands, causes of action, losses, damages or expenses (including all attorney’s fees and litigation expenses) attributed to errors or defects in data, information or documents, including drawings and specifications, resulting from the contractor’s distribution of electronic files to other contractors, persons, or entities.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 Attached “Agreement” shall be submitted with accompanying payment to the Engineer prior to delivery of electronic files.

END OF SECTION 270502
Project: Dayton Metropolitan Library System  
Southeast Branch  
Dayton, Ohio

Owner: Dayton Metropolitan Library System

Heapy Engineering Project Number: 2016-91026

Heapy Engineering Project Manager: James Krile

The Provider, named below, will furnish the Recipient, named below, certain documents prepared by the Provider or its sub consultants in an electronic format. These documents are hereinafter collectively referred to as "Electronic Files". The Electronic Files are instruments of the Provider services performed solely for the Owner's benefit and to be used solely for this Project. The Provider does not represent that the information contained in the Electronic Files are suitable for use on any other project or for any other purpose. If the Electronic Files are used for any other project or purpose without the Provider's specific written permission, the risk of such use shall be assumed solely by the Recipient or other user.

Prior to the use of the Electronic Files the Provider and the Recipient agree to the following terms and conditions:

1. The Provider and Recipient fully understand that the data contained in these electronic files are part of the Provider’s Instruments of Service. The Provider shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

2. The Recipient confirms their request to the Provider for Electronic Files for the Project listed above, which the Recipient understands are to be provided only in accordance with, and conditioned upon, the terms and conditions of this Agreement and Waiver for Use of Electronic Files.

3. The Provider agrees that the Recipient may use the Electronic Files for the sole purpose of preparing shop drawings and/or coordination drawings for the above Project only. Any Electronic Files provided are strictly for the use of the Recipient in regard to the Project named above, and shall not be utilized for any other purpose or provided by the Recipient to any entity other than its subcontractors for the Project named above.

4. The Recipient acknowledges that the furnishing of Electronic Files in no way relieves the Recipient from the responsibility of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

5. The Recipient acknowledges:
a. That the Electronic Files do not contain all of the information of the Bid Documents or Contract Documents for the construction of the Project above.

b. That information in the Bid Documents or Contract Documents may be revised or modified in the future.

c. The Provider does not have, and will not have, any duty or obligation to advise or give notice to the Recipient of any such revisions or modifications.

d. That the Recipient agrees that its use of the Electronic Files is at the Recipient’s sole risk of liability, and that the Recipient shall make no claim or demand of any kind against the Provider arising out of Recipient’s receipt or use of the Electronic Files.

6. The Provider makes no representation or warranty of any kind, express or implied, with respect to the Electronic Files and specifically makes no warranty that the Electronic Files shall be merchantable or fit for any particular purpose, or accurate or complete. Furthermore, any description of said Electronic Files shall not be deemed to create an implied or express warranty that such Electronic Files shall conform to said description.

7. Due to the unsecured nature of the Electronic Files and the inability of the Provider or the Recipient to establish controls over their use, the Provider assumes no responsibility for any consequences arising out of the use of the data. It is the sole responsibility of the Recipient to check the validity of all information contained within the Electronic Files. The Recipient shall at all times refer to the Construction Documents of the project during all phases of the project. The Recipient shall assume all risks and liabilities resulting from the use of this data, and the Recipient agree(s) to waive any and all claims and liability against the Provider and its sub consultants resulting in any way from the use of the Electronic Files.

8. Electronic Files are provided strictly as a courtesy by the Provider solely for the convenience of the Recipient, and are not part of the Bid Documents or Contract Documents for the Project. The Electronic Files do not replace or supplement the paper copies of any drawings, specifications, or other documents included in the Contract Documents for use on the project.

   a. The Recipient assumes full responsibility in the use of Electronic Files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

9. As stated herein, the possibility exists that the Electronic Files provided may differ from the Bid Documents or Contract Documents for construction of the Project. The Provider shall not be responsible, nor be held responsible, for differences between Electronic Files, the Bid Documents, and Contract Documents. The Bid Documents or Contract Documents for the Project may be modified by the Provider at any time, either before or after construction begins. The Provider has no responsibility, either before or after any such modification, to determine or to advise the Recipient whether any such modification causes Electronic Files provided to the Recipient to be out of date, inconsistent with the Bid Documents or Contract Documents, or otherwise unsuitable or unfit for use in any way.

10. The Recipient assumes all risk and liability for any losses, damages, claims, or expenses (including defense and attorney fees) resulting from its receipt, use, or possession of Electronic
Files furnished by the Provider. The Provider makes no representation, warranty or guarantee that the Electronic Files:

a. Are suitable for any other usage or purpose.

b. Have any particular durability.

c. Will not damage or impair the Recipient's computer or software.

d. Contain no errors or mechanical flaws or other discrepancies that may render them unsuitable for the purpose intended by the Recipient.

11. Recipient agrees to indemnify, defend and hold harmless the Provider, agents, employees, and the Owner from, and against, any and all claims, suits, losses, damages or costs, of any kind or nature, including attorney's fees, arising from or by reason of the Recipient's use of Electronic Files provided by the Provider, and such defense and indemnification obligation duties shall survive any use under this Agreement and Waiver for Use of Electronic Files.

12. The Recipient agrees that the Provider shall have no responsibility whatsoever for problems of any nature arising from transmitting and storing electronic files at a Recipient requested FTP or project management site or the conversion of the Electronic Files by the Recipient or others for use in non-native applications. The Provider will not provide Electronic Files in compressed formats. Recipient agrees to accept the files in the format provided by the Provider, and that Recipient's conversion or electronic file storage at the Recipient's requested site, shall be at Recipient's sole risk.

13. Recipient acknowledges:

a. That the Electronic Files provided by the Provider are a graphical representation of the building in order to generate two-dimensional industry standard drawings.

b. That the data contained in the Electronic Files may not be 100% accurate and should not be used for dimensional control, building layout, shop drawings, or any other similar purpose.

c. That any schedule of materials produced directly from the Electronic Files has not been checked for accuracy.

d. That the information in the Electronic Files should be used only for comparative purposes and shall not be relied upon for accurate quantity estimates or used in establishing pricing.

14. Electronic Files provided by the Provider will only contain elements and content that the Provider deems necessary and appropriate to share. No specific Level of Detail (LoD) is implied or expected. The Recipient agrees that no proprietary content, MvParts or Revit Families or any other AutoCAD MEP or Revit MEP content shall be removed from the model and/or used for any other purpose but to support this specific project.

15. The Provider, at its sole discretion, may modify the Electronic files before they are provided to the Recipient. Such modifications may include, but are not necessarily limited to, removal of
certain information. The Provider, at its sole discretion, may refuse to provide some or all Electronic Files requested by Recipient.

16. The availability of Electronic Files that were not prepared by the Provider is subject to the consent of the Owner or consultant that prepared those Electronic Files. The Provider will not negotiate with the Owner or consultant or repeatedly solicit the Owner or consultant to obtain such consent. Neither this Agreement and Waiver for Use of Electronic Files nor any such separate Consultant’s consent may be assigned or transferred by Recipient to any other person or entity.

Provider (Name of Company): ____________________________________________

Recipient (Name of Company): ____________________________________________

Recipient Address: ______________________________________________________

Name of authorized Recipient Representative: ________________________________

Title of authorized Recipient Representative: ________________________________

E-mail address of authorized Recipient Representative: ________________________

Signature of authorized Recipient Representative: ____________________________

Date: __________________________________________________________________

NOTE: Select requested Electronic File format and complete applicable cost summary.

1.  □ DWG / DXF Format - List of Drawings Requested: ____________________________

2.  □ Revit Project Model Requested (Model only, no Views included)

The following costs are applicable to Delivery of Electronic Files (select one):

☐ CD-ROM  ☐ Heapy FTP  ☐ User’s FTP site  ☐ Flash Drive

Cost of Preparation of Division 27 Electronic DWG / DXF Files:

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<tr>
<th>Description</th>
<th>Quantity</th>
<th>Cost</th>
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<td>First Drawing</td>
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<td>Additional Drawings</td>
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All files will be bound together.

Requested electronic Revit file format (Select One):

☐ 2009 RVT  ☐ 2010 RVT  ☐ 2011 RVT  ☐ 2012 RVT  ☒ 2017 RVT

Cost of Preparation of Division 27 Electronic Revit Model Files:

ELECTRONIC FILES RELEASE FORM TO CONTRACTORS  SECTION 270502A - 4
Revit Project Model without Views $500.00

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $__________
SECTION 270504  BASIC COMMUNICATIONS MATERIALS AND METHODS

PART 1 - GENERAL

1.1 TEMPORARY TELECOMMUNICATION SERVICES

A. The temporary communications for construction is provided by the Contractor. Refer to Division 01 – General Requirements.

B. The use of the permanent telecommunication system for temporary services during the latter stages of construction shall be allowed. Expedite completion of system as practicable to this end. Maintain the system during this period.

C. Warranty periods on equipment, materials and systems shall commence upon Owner acceptance of the building or systems. Temporary use shall not jeopardize or alter warranty requirements.

D. The complete temporary service shall comply with Telephone Company, Owner Facility, OSHA and all Code requirements.

1.2 CONTINUITY OF SERVICE

A. Work shall be so planned and executed as to provide reasonable continuous service of existing systems throughout the construction period. Where necessary to disrupt services for short periods of time for connection, alteration or switch over, the Owner and Construction Manager shall be notified in advance and outages scheduled at the Owner's reasonable convenience.

B. Submit, on request, a written step-by-step sequence of operations proposed to accomplish the work. The outline must include tentative dates, times of day for disruption, downtime and restoration of services. Submit the outline sufficiently in advance of the proposed work to allow the Architect or Engineer and Construction Manager to review the information with the Owner. Upon approval, final planning and the work shall be done in close coordination with the Owner.

C. Shutdown of systems and work undertaken during shutdowns shall be bid as being done during normal working hours. If the Owner should require such work be performed outside of normal working hours, reimbursement shall be made for premium time expenses only, without mark up.

PART 2 - PRODUCTS

2.1 ACCESS PANELS

A. Provide ceiling and wall access panels where indicated on the drawings, or where otherwise required to gain access to concealed junction boxes, pull boxes, devices and equipment requiring service or adjustment.

B. Access panels (refer to paragraph below for more specialized drywall ceiling access panels) shall be steel construction (except where aluminum or stainless steel is specified) with concealed hinge and door with screwdriver lock. Panels shall be 18 inch x 18 inch size unless
larger panels are shown or required. Mounting frames shall be compatible with the material in which they are installed. Access panels shall be:

1. Standard flush type with overlapping flange for masonry and tile walls.
2. Standard flush type for drywall ceilings and walls, Milcor style “M” or equal.

C. Access panels in drywall ceilings shall be glass reinforced gypsum drywall lay-in panels with flush mounting frames. Corners of panels shall be rounded. Panels shall be 18 inches x 18 inches unless larger panels are shown or required.

D. Access panels in fire rated shaft walls and in fire rated ceilings shall be "B" label or greater to match the rating of the wall or ceiling.

E. Materials used in plenums shall be rated for plenum use conforming to the ASTM E84 25/50 smoke development and flame spread restrictions.

PART 3 - EXECUTION

3.1 WORKMANSHIP

A. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all respects, and the Architect and Engineer shall have the right to stop the work if highest quality workmanship is not maintained.

B. Electrical work shall be performed by a licensed Contractor in accordance with requirements of the jurisdiction.

C. Communication work shall be performed by certified Contractor in accordance with the respective specification and system requirements.

3.2 PROTECTION

A. The Contractor shall be entirely responsible for all material and equipment furnished in connection with his work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect or Construction Manager.

B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide drop cloths and visqueen or similar barriers where dust and debris is generated, to protect adjacent areas.

3.3 CUTTING AND PATCHING

A. Refer to Division 01 - General Requirements for information regarding cutting and patching.

B. Plan the work well ahead of the general construction. Where conduits, wireways and cable trays are to pass thru new walls, partitions, floors, roof or ceilings, place sleeves in these elements or arrange with the General Contractor to provide openings where sleeves are not practical. Where sleeves or openings have not been installed, cut holes and patch as required for the installation of this work, or pay other trades for doing this work when so directed by
the Architect or Construction Manager. Any damage caused to the building shall be repaired or rectified.

C. Where conduits, wireways and cable trays are to pass thru, above or behind existing walls, partitions, floors, roof or ceiling, cutting, patching, refinishing and painting of same shall be included in this contract. Core drilling and saw cutting shall be utilized where practical. Contractor to examine where floors and walls, etc. are to be cut for presence of existing utilities.

D. When cutting or core-drilling floor verify location of existing electrical, plumbing or steel reinforcement. Use X-ray method to verify existence of obstructions. Either re-route existing system brace floor or alter location of new work to maintain existing system.

E. All sleeves and openings not used or partially used shall be closed to prevent passage of fire or smoke.

F. All materials, methods and procedures used in patching and refinishing shall be in accordance with applicable provisions of specifications governing the various trades, and shall be completed by skilled workmen normally engaged in these trades. The final appearance and integrity of the patched and refinished areas must meet the approval of the Architect. Wall, floor and ceiling refinishing must extend to logical termination lines (entire ceiling of the room repainted, for instance), if an acceptable appearance cannot be attained by finishing a partial area.

G. Provide steel angle or channel lintels to span openings which are cut in existing jointed masonry walls where the opening span exceeds 16 inches. Provide framing around roof openings for required support of the roof deck.

H. Engage a Roofing Contractor on a subcontract basis for roofing and roof insulation work necessitated by the Communications work. The Roofing Sub-Contractor shall be certified for installation and repair of the roofing system so as to maintain the existing roofing warranty.

3.4 PAINTING

A. In addition to any painting specified for various individual items of equipment, the following painting shall be included in Division 27:

1. Ferrous metal which is not factory or shop painted or galvanized and which remains exposed to view in the building including finished areas, mechanical rooms, storage rooms, and other unfinished areas shall be given a prime coat of paint and two finish coats of paint.
2. Ferrous metal installed outside the building which is not factory or shop painted or galvanized shall be given a prime coat of paint and two finish coats of paint.
3. Equipment and materials which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refininished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch up.
4. Apply Z.R.C. Galvilite cold galvanizing compound, or approved equal, for touch-up and repair of previously galvanized surfaces.
5. Each backboard shall be painted with a minimum of two coats of flame retardant paint, all sides; gray enamel primer with gray matte enamel finish.
B. Paint, surface preparation and application shall conform to applicable portions of the Painting section of Division 09 of the Specifications. All rust must be removed before application of paint.

C. Finish painting is included in the General Contract except where otherwise required under remodeling work. Refer to the Cutting and Patching paragraph in this Section for finishing requirements.

3.5 ACCESS PANELS

A. Install access panels or pay general trade to do so. Final appearance is subject to approval by the Architect or Engineer.

B. Location of access panels shall be planned to clear ceiling lights, ceiling support grids and other obstructions so as to allow, wherever possible, full shoulder clearance beside the device to be inspected, adjusted or repaired.

C. Panels with recessed doors are to be fitted with insert panels of drywall or, those for plaster, infilled with plaster. Caution the Installing Contractor to provide appropriate framing with drywall or plaster beading to ensure a finished appearance. Shim strips may be required to bring the insert panel flush with the plane of the door and wall / ceiling.

END OF SECTION 270504
SECTION 270505 - FIRESTOPPING

PART 1 - GENERAL

1.1 Firestopping assemblies shall be provided at penetrations of conduits, bus ducts, cables, cable trays and other electrical items thru fire rated floors, fire rated floor-ceiling and roof ceiling assemblies, fire rated walls and partitions and fire rated shaft walls and partitions. In addition, firestopping assemblies shall be provided at penetrations thru 0-hour rated floors. Refer to the drawings for fire rated building elements.

1.2 Firestopping assemblies shall be tested and rated in accordance with ASTM E814, E119 and listed in accordance with UL 1479, as published in the UL Fire Resistance Directory. Firestopping shall provide a fire rating equal to that of the construction being penetrated.

1.3 Firestopping materials, assemblies and installation shall conform to requirements of the OBC / Chapter 1, Section 106 and Chapter 7, Section 712 and the Authority Having Jurisdiction.

1.4 For those firestopping applications that exist for which no UL tested system is available through any manufacturer, a manufacturer’s engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council.

1.5 Shop drawings shall be prepared and submitted for review and approval. Submittals shall include manufacturer’s specifications and technical data of each material, documentation of U.L. firestopping assemblies and installation instructions. Submittals shall include all information required in OBC Chapter 1, Section 106 and Chapter 7, Section 712.

PART 2 - PRODUCTS

2.1 Firestopping materials shall be manufactured and/or supplied by Hilti, 3M, Rectorseal-Metacaulk, Tremco, Nelson, Specified Technologies or other approved manufacturer.

2.2 Materials shall be in the form of caulk, putty, sealant, intumescent material, wrap strip, fire blocking, ceramic wool and other materials required for the UL listed assemblies. These shall be installed in conjunction with sleeves and materials for fill and damming.

2.3 Combination pre-set floor sleeve and firestopping assemblies shall be equal to Hilti CP 680.

PART 3 - EXECUTION

3.1 Installation of all materials and assemblies shall be in accordance with UL assembly drawings and the manufacturer’s instructions.

3.2 Installation shall be done by an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having the necessary training and experience.

END OF SECTION
SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Work includes the provision of the technical grounding system including connections within technology rooms/closets.

B. Work includes bonding of technology pathways and equipment to the technical grounding system.

1.2 SYSTEM DESCRIPTION

A. Provide a Telecommunications Main Ground Bar (TMGB) in the new TR. This ground bar shall be electrically bonded to the Building Main Electrical Service Ground with a minimum insulated, #2/0, copper grounding conductor.

B. Provide bonding between all joints of cable tray and ladder rack. Provide bonding to all conduit sleeves. Provide bonding to all technology equipment racks and cabinets within each wiring closet.

C. Provide bonding from the Technology grounding system to the telephone and CATV demarc equipment and protector panels. Coordinate this grounding prior to installation of telephone and CATV services.

D. This contract shall be responsible for providing all equipment, cable tray, ladder rack, conduit and sleeve grounding in each TC to the grounding system installed under Division 26.

E. All work shall be in compliance with NEC, Article 250 and EIA/TIA J-STD-607.

1.3 QUALITY ASSURANCE

A. All work shall be installed in compliance with the latest edition of the Commercial Building Telecommunications Wiring Standard EIA/TIA, BICSI Standards, applicable National Electric Code Sections, Ohio Building Codes.

B. All equipment shall be UL listed.

1.4 SHOP DRAWINGS

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

1.5 RELEVANT STANDARDS

A. The Telecommunications Grounding Installation shall comply with the following at a minimum:
1. All local, state and national codes
2. The National Electric Code (NEC)
3. The National Electrical Safety Code (NESC)
4. Electronic Industries Alliance (EIA) / Telecommunications Industry Association (TIA)
   606, J-STD-607 and all applicable and current Technical Service Bulletins (TSB).

PART 2 - PRODUCTS

2.1 TELECOMMUNICATIONS MAIN GROUND BAR (TMGB)

   A. Ground bar shall be solid copper, 4 inches high, .25 inch thick, minimum 24 inches long with
      pre-drilled holes for standard-sized Lugs and must be UL listed. Provide final length as
      required to accommodate grounding lug attachments.

   B. Ground bars shall be provided with insulated stand-off brackets for wall mounting providing a
      minimum of 2 inch wall clearance. Insulators shall have a minimum voltage rating of 600V
      and a minimum Short Time Electrical Strength of 55kVv.

   C. All connections shall be made with double-bolted, compression style grounding lugs.

   D. Manufactured by StormCopper or equal by B-Line, Andrew, Tessco Technologies or
      Chatsworth.

2.2 TELECOMMUNICATIONS BONDING CONDUCTOR (TBC)

   A. Insulated Conductors - Soft, annealed bare copper per ASTM B-3. Concentric, compressed
      stranded (class B or C Alternate ASTmB-787) per ASTM B-8, UL-83 and UL-854. Insulation
      Jacket: Nylon per UL-83. Insulation: High dielectric polyvinyl chloride per UL-83 and UL-
      854.

   B. Uninsulated Conductor: Soft, annealed bare copper per ASTM B-3. Stranded as specified
      herein. Overall Finish: Gray polyvinyl chloride (PVC) per UL-824.

   C. All connections shall be made with double-bolted, compression style grounding lugs.

   D. RATINGS - Cables conform to the following standards:
      1. UL-83 for THHN-THWN Cdrs.
      2. Federal Specification J-C-30B

2.3 BONDING CONDUCTORS

   A. Conductor shall be minimum #6AWG and may be either stranded or solid, insulated or bare.

   B. Cable as manufactured by Superior/Essex, Rome, AIWC.

   C. All connections shall be made with double-bolted, compression style grounding lugs.

PART 3 - EXECUTION

3.1 GENERAL
A. The telecommunications grounding system shall provide an electrically continuous, low impedance path for all connected telecommunications equipment and pathways.

B. When using grounding conductors installed in rigid, ferrous metallic conduit, both ends of the bonding conductor must be bonded to the conduit ends.

C. The bonding conductors shall have no splices or connections.

D. The bonding conductor shall be connected to the building main electrical grounding system through the use of exothermic weld, listed lugs, listed pressure connectors, listed clamps, or other listed means.

E. All metallic telecommunications pathways and equipment within telecommunications spaces shall be bonded to the local TGB/TMGB utilizing Bonding Conductors (BC).

3.2 WIRING

A. Refer to drawings for specific location and arrangement of telecommunications Bonding Backbone and Telecommunications Ground bars.

B. The drawings do not indicate specific routes for telecommunications grounding cables. The Telecommunications Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental cable management pathways and systems so that all structured cabling adhere to specific codes and standards specifically developed for the installation of such cables. Where the use of existing cable management systems and pathways would cause the grounding system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc, the Telecommunications Contractor shall be responsible for developing alternative pathways and shall include all labor and material for doing so within the scope of this work.

C. TR-01 shall be provided with the Main Telecommunications Ground Bar (TMGB). The TMGB shall be bonded to the building electrical system ground and shall be bonded to one additional building electrical system ground (such as building steel).

3.3 GROUNDING/BONDING CONNECTIONS

A. Ground all backbone cable sheaths, shield drain wires from all voice/data horizontal cable, equipment racks and equipment to the local TGB / TMGB.

B. All grounding and bonding shall be in conformance with the National Electric Code, article 250 and as recommended by EIA/TIA-607.

C. All joints of all cable tray and ladder rack shall be bonded together. When bonding to painted equipment, methods shall be utilized to ensure continuity of grounding connection.

D. Telephone and CATV Service entrance equipment and primary protection panels, shall be bonded to the technical grounding system. Coordinate with serving utilities regarding configuration of grounding connections.
E. All connection to ground bars (TGB, TMGB) shall be made using listed lugs appropriate for mounting provisions in the supplied ground bar.

3.4 TESTING GENERAL

A. The Contractor shall be responsible for testing the complete technology grounding system.

B. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted.

C. Test reports shall be provided to indicate.

   1. Impedance values across the TBC from the TMGB to the main electrical service ground.

D. Instruments and labor required for tests shall be furnished by the Contractor. All system test equipment shall be approved by the Owner/Architect/Engineer prior to application.

E. Instruments required for tests shall be furnished by the Contractor.

3.5 LABELING

A. The Contractor shall be responsible for labeling all telecommunications grounding equipment, cable, etc. in accordance with the guidelines as described herein.

B. Each telecommunications ground bar shall be provided with a warning label to read:

   1. “WARNING: Building telecommunications grounding system. Do not remove or disconnect without prior approval from building Telecommunications Department.”

C. Each Telecommunications Bonding Conductor (TBC, TBB, GE, etc.) to be provided with a label indicating source and destination ground bars.

3.6 WARRANTY

A. The entire grounding and bonding system as specified herein shall be guaranteed against defects in workmanship and materials for a period of one (1) year as described herein. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. The Installing Contractor shall provide the initial warranty service. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

END OF SECTION 270526
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Grounding conductors.
   2. Grounding connectors.
   3. Grounding busbars.
   4. Grounding rods.
   5. Grounding labeling.

1.2 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.
B. EMT: Electrical metallic tubing.
C. TGB: Telecommunications grounding busbar.
D. TMGB: Telecommunications main grounding busbar.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
   1. Ground rods.
   2. Ground and roof rings.
   3. BCT, TMGB, TGBs, and routing of their bonding conductors.

B. Qualification Data: For installation supervisor, and field inspector.
C. Qualification Data: For testing agency and testing agency's field supervisor.
D. Field quality-control reports.
1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Installation Supervision: Installation shall be under the direct supervision of ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.

2. Field Inspector: Currently registered by BICSI as a registered communications distribution designer to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 SYSTEM COMPONENTS

A. Comply with J-STD-607-A.

2.2 CONDUCTORS

A. Comply with UL 486A-486B.

B. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.

2. Cable Tray Equipment Grounding Wire: No. 6 AWG.

C. Bare Copper Conductors:


4. Bonding Cable: 28 kcmils (14.2 sq. mm), 14 strands of No. 17 AWG conductor, and 1/4 inch (6.3 mm) in diameter.

5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
2.3 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

B. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
   1. Electroplated tinned copper, C and H shaped.

C. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch (15.8- or 25.4-mm) centers for a two-bolt connection to the busbar.

D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

A. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with J-STD-607-A.
   1. Predrilling shall be with holes for use with lugs specified in this Section.
   2. Mounting Hardware: Stand-off brackets that provide a 4-inch (100-mm) clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
   3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

B. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches (6.3 by 50 mm) in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with J-STD-607-A.
   1. Predrilling shall be with holes for use with lugs specified in this Section.
   2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch ((50-mm) clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.)
   3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with J-STD-607-A. Predrilling shall be with holes for use with lugs specified in this Section.
   1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch (483- or 584-mm) equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.

2.5 GROUND RODS

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet (19 mm by 3 m) in diameter.

2.6 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with J-STD-607-A.

3.3 APPLICATION

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

B. Underground Grounding Conductors: Install bare copper conductor, No. 2 AWG minimum.

C. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.

D. Conductor Support:
   1. Secure grounding and bonding conductors at intervals of not less than 36 inches (900 mm).

E. Grounding and Bonding Conductors:
   1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
   2. Install without splices.
   3. Support at not more than 36-inch (900-mm) intervals.
   4. Install grounding and bonding conductors in 3/4-inch (21-mm) PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

   a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.4 GROUNDING ELECTRODE SYSTEM

A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 3/0 AWG.

3.5 GROUNDING BUSBARS

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 12 inches (300 mm) above finished floor unless otherwise indicated.
B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.6 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
   1. Use crimping tool and the die specific to the connector.
   2. Pretwist the conductor.
   3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot (1 sq. mm/linear meter) of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.

I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA/EIA-568-B.1 and TIA/EIA-568-B.2 when grounding screened, balanced, twisted-pair cables.

J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

3.7 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.
1. Label TMGB(s) with "TMGB."
2. Label TGB(s) with "TGB."
3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
   a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.
3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
   a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable ac current level is 1 A.

C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 27 05 26
PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Work consists of pathways to carry communication wiring of all descriptions, including cable management systems.

B. Work includes support equipment for telecommunications cabling including backboards, rough-in boxes and cabinets.

1.2 QUALITY ASSURANCE

A. Communications pathways and support equipment shall be closely coordinated with other trades to provide adequate access, appropriate clearances and required separation between systems.

1.3 SHOP DRAWINGS

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

1.4 DRAWINGS

A. The drawings, which constitute a part of these bid documents, indicate the general route of the pathways to carry communication wiring systems. Data presented on these drawings are as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification, of all dimensions, routing, etc., is directed.

B. Specifications and drawings are for assistance and guidance, but exact routing, locations, distances and levels will be governed by actual field conditions. Contractor is directed to make field surveys as part of his work prior to submitting system layout drawings.

1.5 RELATED WORK BY OTHERS

A. Communications cabling shall be included as stated in the specification section for each individual system.

PART 2 - PRODUCTS

2.1 CABLE MANAGEMENT SYSTEM

A. Provide pre-manufactured cable supports as manufactured by Chatsworth, Panduit, Cooper B-Line, Caddy, Mineralac, Mono-Systems or Rayco. Cable supports shall be secured to building structure through threaded rod, beam clamps or other UL approved supports as required by
site conditions. Components shall provide a minimum cable support point spacing of 48 inches.

B. Cable management devices must be sized to accommodate 100 percent spare capacity of the final installed cable base.

C. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bend, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building’s structure such as beams, joists, etc. to hang cable from will not be acceptable.

D. Bridle rings shall not be acceptable.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Refer to drawings for pathway types, locations and routing.

B. Cable pathways shall provide the following minimum clearances:

1. Motors and transformers – 4 ft.
2. Conduit and cable used for electrical power distribution – 1 ft.
3. Fluorescent lighting – 5 inches.
4. Power lines up to 5 kV – 5 inches.
5. Power lines over 5 kV – 24 inches.

C. Restore fire rating and smoke stoppage integrity where all wireways, raceways and cable trays pierce walls, floors and ceilings by sealing with approved means; refer to 27 05 33 Raceway and Boxes for Communications Systems paragraph.

D. Provide necessary pathways in areas that have exposed structure or plastered ceilings to provide a wiring path for cables from area above suspended ceilings to respective backboards.

E. No non-metallic or combustible materials shall be installed in ceiling or other plenums used for circulating room air used for heating, ventilation or cooling.

3.2 Conduit Systems – Coordinate with Division 26 Contractor to ensure that conduit system installed for telecommunications cabling shall conform to the following:

A. No section of conduit shall be longer than 100 feet between pulling points.

B. No more than two 90 deg. bends in a section of conduit between pulling points.

C. Each section of conduit shall be labeled for length, destination closet and origination closet.

D. Refer to EIA/TIA 569-A for specific conduit and pull box requirements.
E. Conduit and wiring above accessible ceilings shall be run as high as possible, above piping and ductwork, so as to not interfere with mechanical trades, access to mechanical and electrical devices and to allow freedom to remove ceiling panels.

F. Provide a No. 12 gauge pull wire or nylon pull cord in each empty conduit run.

3.3 CABLE MANAGEMENT SYSTEM

A. The drawings do not indicate specific routes for telecommunications cables. The Division 27 Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental management pathways and systems so that all structured cabling adhere to specific codes and standards specifically developed for the installation of such cables. Where the use of existing cable management systems and pathways would cause the structured cable system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc., the Division 27 Contractor shall be responsible for developing alternative pathways and shall include all labor and material for doing so within the scope of this work.

B. In areas where there is not an installed raceway system (conduits or cable tray) and a cable support system is required, this contract shall be responsible for providing a cable management system. Where cables are installed open wired through the use of cable management systems, they shall be installed such that there is a minimum sag of 4 inches for every 4 foot of horizontal run. Cable pathways shall provide the following minimum clearances:

1. Motors and transformers – 4 feet.
2. Conduit and cable use for electrical power distribution – 1 feet.
3. Fluorescent lighting – 5 inch.
4. Power lines up to 2kVA – 5 inch.
5. Power lines over 5kVA – 24 inch cable management system shall be secured to building structure utilizing manufactured approved methods and hardware.

C. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building’s structure such as beams, joists, etc. to hang cable from will not be acceptable.

3.4 Restore fire rating and smoke stoppage integrity where all wireways, raceways and cable trays pierce walls, floors and ceilings by sealing with approved means.

END OF SECTION 270528
SECTION 27 05 28 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Metal conduits and fittings.
   2. Nonmetallic conduits and fittings.
   3. Optical-fiber-cable pathways and fittings.
   4. Metal wireways and auxiliary gutters.
   5. Nonmetallic wireways and auxiliary gutters.
   8. Handholes and boxes for exterior underground cabling.

B. Related Requirements:
   1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
   2. Section 260533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid steel conduit.

C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

D. Samples: For wireways, nonmetallic wireways, and surface pathways and for each color and texture specified, 12 inches (300 mm) long.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of pathway groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Seismic Qualification Certificates: For pathway racks, enclosures, cabinets, equipment racks and their mounting provisions, including those for internal components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.

D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Manufacturers:
1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a part of Atkore International.
3. Alpha Wire.
4. Anamet Electrical, Inc.
5. Electri-Flex Company.
6. O-Z/Gedney; a brand of Emerson Industrial Automation.
7. Picoma Industries, Inc.
8. Republic Conduit.
10. Southwire Company.
12. Western Tube and Conduit Corporation.

B. General Requirements for Metal Conduits and Fittings:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-B.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. ARC: Comply with ANSI C80.5 and UL 6A.

E. IMC: Comply with ANSI C80.6 and UL 1242.

F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch (1 mm), minimum.

G. EMT: Comply with ANSI C80.3 and UL 797.

H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
   1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
   2. Fittings for EMT:
      a. Material: Steel.
      b. Type: Setscrew.
   3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
   4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
1. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Manufacturers:

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a part of Atkore International.
3. Anamet Electrical, Inc.
4. CANTEX, Inc.
5. Carlon; a brand of Thomas & Betts Corporation.
6. CertainTeed Corporation.
8. Dura-Line.
10. Kraloy.
11. Niedax, Inc.
12. RACO; Hubbell.

B. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. Rigid HDPE: Comply with UL 651A.

E. Continuous HDPE: Comply with UL 651B.

F. RTRC: Comply with UL 1684A and NEMA TC 14.

G. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

H. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

I. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS
A. Manufacturers:

1. Alpha Wire.
2. Carlon; a brand of Thomas & Betts Corporation.
3. Dura-Line.
4. Endot Industries, Inc.
5. IPEX USA, LLC.

B. Description: Comply with UL 2024; flexible-type pathway, approved for plenum installation unless otherwise indicated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers:

2. Hoffman; a brand of Pentair Equipment Protection.
3. MonoSystems, Inc.
4. Square D; by Schneider Electric.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.5 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers:

1. Allied Moulded Products, Inc.
2. Carlon; a brand of Thomas & Betts Corporation.
3. Hoffman; a brand of Pentair Equipment Protection.
4. Niedax, Inc.
B. General Requirements for Nonmetallic Wireways and Auxiliary Gutters:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

C. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

D. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

E. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

F. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 SURFACE PATHWAYS

A. General Requirements for Surface Pathways:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

B. Surface Metal Pathways: Galvanized steel with snap-on covers complying with UL 5. Prime coated, ready for field painting.

1. Manufacturers:
   a. MonoSystems, Inc.
   b. Niedax, Inc.
   c. Panduit Corporation.
   d. Wiremold/Legrand.

C. Surface Nonmetallic Pathways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL-94 V-0 requirements for self-extinguishing characteristics.

1. Manufacturers:
D. Tele-Power Poles:

1. Manufacturers:
   a. MonoSystems, Inc.
   b. Panduit Corporation.
   c. Wiremold/Legrand.

3. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.7 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers:

1. Adalet.
2. Carlon; a brand of Thomas & Betts Corporation.
4. EGS/Appleton Electric.
5. Erickson Electrical Equipment Company.
6. FSR, Inc.
7. Hoffman; a brand of Pentair Equipment Protection.
8. Milbank Manufacturing Co.
9. Molex Industrial Products Group; Woodhead Brand.
10. MonoSystems, Inc.
11. Oldcastle Enclosure Solutions.
13. Quazite:
14. RACO; Hubbell.
15. Robroy Industries.
16. Spring City Electrical Manufacturing Company.
17. Stahlin Non-Metallic Enclosures.
18. Thomas & Betts.
19. Wiremold/Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-B.
2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.
C. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, [ferrous alloy] [aluminum], Type FD, with gasketed cover.

E. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

F. Metal Floor Boxes:
   1. Material: Cast metal.
   2. Type: Fully adjustable.
   3. Shape: Rectangular.
   4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Nonmetallic Floor Boxes: Nonadjustable, rectangular.
   1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

J. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).

K. Gangable boxes are allowed.

L. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Nonmetallic Enclosures:
      b. Finished inside with radio-frequency-resistant paint.
   3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

N. Cabinets:
   1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.8 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLELING

A. General Requirements for Handholes and Boxes:
   1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
   2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   3. Comply with TIA-569-B.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
   1. Manufacturers:
      a. Armorcast Products Company.
      b. Carson Industries, LLC.
      c. NewBasis.
      d. Oldcastle Precast, Inc.
      e. Quazite: Hubbell Power Systems, Inc.
      f. Synertech Moulded Products.
   2. Standard: Comply with SCTE 77.
   3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
   4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
   5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   6. Cover Legend: Molded lettering, "COMMUNICATIONS."
   7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
   8. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of polymer concrete.
   1. Manufacturers:
      a. Armorcast Products Company.
      b. Carson Industries, LLC.
c. NewBasis.
d. Nordic Fiberglass, Inc.
e. Oldecastle Precast, Inc.
g. Synertech Moulded Products.

2. Standard: Comply with SCTE 77.
4. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
7. Cover Legend: Molded lettering, "COMMUNICATIONS."
8. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
9. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.9 SOURCE QUALITY CONTROL FOR UNDERGROUND ENClosures

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed Conduit: [GRC] [IMC] [RNC, Type EPC-40-PVC] [RNC, Type EPC-80-PVC].
2. Concealed Conduit, Aboveground: [GRC] [IMC] [EMT] [RNC, Type EPC-40-PVC].
3. Underground Conduit: RNC, [Type EPC-40-PVC] [Type EPC-80-PVC], [direct buried] [concrete encased].
4. Boxes and Enclosures, Aboveground: NEMA 250, [Type 3R] [Type 4].

B. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: [GRC] [IMC]. Pathway locations include the following:
   a. Mechanical rooms.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Damp or Wet Locations: GRC.
6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway.
7. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: Plenum-type, communications-cable pathway.
8. Boxes and Enclosures: NEMA 250 Type 1.

C. Minimum Pathway Size: 3/4-inch (21-mm) trade size. Minimum size for optical-fiber cables is 1 inch (27 mm).

D. Pathway Fittings: Compatible with pathways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
   3. EMT: Use setscrew or compression, fittings. Comply with NEMA FB 2.10.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

B. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

C. Complete pathway installation before starting conductor installation.

D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
F. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches (300 mm) of changes in direction. Utilize long radius ells for all optical-fiber cables.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches (300 mm) of enclosures to which attached.

I. Pathways Embedded in Slabs:
   1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
   2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
   3. Arrange pathways to keep a minimum of 1 inch (25 mm) of concrete cover in all directions.
   4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
   5. Change from ENT to GRC before rising above floor.

J. Stub-ups to Above Recessed Ceilings:
   1. Use EMT, IMC, or RMC for pathways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

N. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

P. Cut conduit perpendicular to the length. For conduits of 2-inch (53-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

Q. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.
R. Surface Pathways:
   1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
   2. Install surface pathway with a minimum 2-inch (50-mm) radius control at bend points.
   3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

S. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
   1. 3/4-Inch (21-mm) Trade Size and Smaller: Install pathways in maximum lengths of 50 feet (15 m).
   2. 1-Inch (27-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
   3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

T. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.

U. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service pathway enters a building or structure.
   3. Where otherwise required by NFPA 70.

V. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

W. Expansion-Joint Fittings:
   1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
   2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
      a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.

c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.

d. Attics: 135 deg F (75 deg C) temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.

4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

AA. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

BB. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

CC. Set metal floor boxes level and flush with finished floor surface.

DD. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.

2. Install backfill as specified in Section 312000 "Earth Moving."

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction.
as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."

4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits, but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.

7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install handholes with bottom below frost line, 42 inches (1067 mm) below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 27 05 28
SECTION 27 05 44 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
   2. Sleeve-seal systems.
   5. Silicone sealants.

B. Related Requirements:
   1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
   1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
   2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:
   2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
      b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
   1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Stainless steel.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.


C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.
2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
   2. Sealant shall have VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
      b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
   2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
   4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
   5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.
D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
   2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 27 05 44
SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 COMMUNICATIONS SYSTEMS IDENTIFICATION

A. Identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.

B. Structured Cabling System

C. Broadband Cable TV System

D. Audio/Visual equipment

E. Network Electronics

F. Wireless Local Area Network

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 STRUCTURED CABLELING SYSTEM

A. The Contractor shall be responsible for labeling all supplied communications equipment, cable, etc. in accordance with the guidelines as described herein.

B. The end of each cable, each jack, patch panel, cross-connect and rack/backboard shall be labeled utilizing a permanent labeling system. DYMO style labels, or hand written labels WILL NOT BE ACCEPTED.

C. All labeling and recording shall be approved by the Owner and the Engineer prior to application and system testing.

D. Systems tests shall reference the final labeling.

3.2 BROADBAND CABLE TV SYSTEM

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.

B. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.3 AUDIO/VISUAL EQUIPMENT

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.
B. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.4 NETWORK ELECTRONICS

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.

B. The contractor shall be responsible for applying a permanent label to each fiber/copper patch cable to indicate source and destination. This label shall indicate patch panel and port at switch side and switch and port at patch panel side. Fiber jumpers utilized to serve uplinks to remote switches shall be labeled with closet and switch on chassis side and fiber port in chassis on switch side.

C. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

D. Provide a printed, computer generated record of each connected port in each switch. Label shall indicate data jack label, port and switch label and closet label.

3.5 WIRELESS LOCAL AREA NETWORK

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.

B. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

C. Provide a printed, computer generated record of each connected port in each switch. Label shall indicate AP served, port and switch label and closet label.

END OF SECTION 270553
SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The intent of this specification section is to cover the materials and installation of a communications equipment room fitting system as outlined herein and as detailed on the drawings. Work shall consist of:

1. Telecommunications Room termination and cable management including racks, cabinets, ladder rack, backboards, backboard mounted wire management, etc.
2. Cabling pathways including raised floor cable tray, overhead fiber duct, overhead ladder rack, innerduct, etc.
3. Cable management system within racks and cabinets.
4. System labeling conforming to EIA/TIA-606 standards.

1.2 SYSTEM DESCRIPTION

A. Termination Equipment – Racks and Cabinets

B. Cable Management – Ladder rack, rack mounted horizontal and vertical cable management, backboards, backboard mounted cable management.

C. Cabling pathways including overhead ladder rack.

1.3 QUALITY ASSURANCE

A. All work shall be installed in compliance with the latest edition of the Commercial Building Telecommunications Wiring Standard EIA/TIA. BICSI Standards, applicable National Electric Code Sections, Ohio Building Codes.

1.4 SHOP DRAWINGS

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

1.5 RELEVANT STANDARDS

A. The structured cabling installation shall comply with the following at a minimum:

1. All local, state and national codes.
2. The National Electric Code (NEC)
3. The National Electrical Safety Code (NESC)
4. Electronic Industries Alliance (EIA) / Telecommunications Industry Association (TIA) 526, 568, 569, 598, 606, J-STD-607, 758 and all applicable and current Technical Service Bulletins (TSB).
PART 2 - PRODUCTS

2.1 PRODUCT EQUIVALENCY

A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor's expense.

B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

2.2 FREE STANDING 19 INCH RELAY RACKS

A. Open style four post data racks shall be 19 inches wide, 84 inches high, and shall meet EIA standards. Racks shall be listed to the UL 1863 Standard for Communication Circuit Accessory. Both vertical and horizontal cable management systems must be provided on all relay racks. All racks must be grounded to the building technical grounding system.

B. Provide a full height front/rear vertical wire management panel with integral cable spools with each floor mounted rack on each side. Where multiple racks are ganged together, there shall be one vertical wire management section between each two racks and one additional section at each end of the line-up.

C. Provide one - six outlet power strip with integral surge suppression and a 10 ft. cord with 20A plug in each rack. Each plug strip to connect to rack mounted UPS unit. Refer to drawings for quantities and locations.

D. Coordinate location at each rack with Owner.

E. Racks and cabinets shall be manufactured by ADC, Great Lakes, Middle Atlantic, Panduit, Hubbell, XMARK, Rittal, Chatsworth, B Line or APW.

F. Refer to drawings for quantities and arrangement.

2.3 OVERHEAD LADDER RACK

A. Runway shall be tubular steel, ladder type with 1.50 inch stringer height with welded rungs. Refer to plans for width. Stringer side rail shall conform to the minimum chemical and mechanical properties of ASTM A513 Grade 1008 steel.

B. Cable runway shall be flat black powder coat, including all fittings, hardware, and accessories.

C. All fittings, supports, splices, etc. for the runway system shall be installed to provide a complete assembly – including fasteners, hardware and other items required to complete the installation as indicated on the drawings.
D. Cable runway shall be capable of carrying a uniformly distributed load of 95 lbs./ft. on a 5-foot support span with a safety factory of 1.5 when supported as a simple span. Load and safety factors specified are applicable to both side rails and rung capacities.

E. Ladder Rack as manufactured by B-Line, Damac, Hubbell, ICC, Great Lakes.

F. Refer to drawings for quantities and arrangement.

2.4 BACKBOARDS

A. On all walls in each TR, backboards shall be provided for wall mounting of devices and technology equipment.

B. General

1. Backboard shall be 0.75 inch thick waterproof flame retardant A-C grade plywood secured to structure. The “A” side shall be facing out.
2. Each board shall be painted with fire retardant paint. The fire-rating stamp shall not be painted and shall remain visible.
3. Backboards shall be normally 4 ft. x 8 ft. mounted 6 inch above floor. Where other sizes are required, they will be noted on the drawings.

C. Refer to drawings for quantities and arrangement.

2.5 BACKBOARD MOUNTED CABLE MANAGEMENT

A. D-Rings

1. Non-conductive, smooth bearing. Available in 2x2, 3x3, 3x5. Size as required for 50 percent spare capacity.
2. Provide on backboards for management of cabling.

B. Slotted Raceway

1. Provide non-metallic, wall mounted slotted raceway with covers, Available in 2x2/3x3/4x4. Refer to plans for locations. Size as required for 50 percent spare capacity.

PART 3 - EXECUTION

3.1 General Installation

A. Refer to drawings for quantity and arrangement of Telecom Room equipment.

B. Where cabling is routed along backboards, utilize wall mounted cable management systems to provide cable support at an interval no less than 60 inch O.C.

C. Telecommunications Rooms – Provide ladder rack in telecommunications rooms in configurations as indicated on the drawings.

D. Provide cable drop outs at each rack location.
E. Where routed above racks, provide additional anchors to the racks.

3.2 TELECOMMUNICATIONS ROOMS

A. The lay-out of the telecommunications rooms as depicted on the drawings shall be utilized as a general guide for bidding purposes. The final room layout shall be carefully coordinated with input from the Owner and from other trades with equipment and/or cabinets to be placed in the room. Final configuration of telecom rooms shall be submitted to Engineer as a coordination drawing with information from all other trades occupying the same room for review prior to permanent mounting of equipment or termination of cabling.

B. Provide ladder rack in telecommunications rooms in configurations as required by final room layout.

C. Coordinate layout of telecom rooms to avoid placing telecommunications equipment and cabinets under water piping (other than sprinkler heads) or HVAC units.

D. Coordinate layout of telecom rooms with electrical plans and locations of electrical outlets.

E. Layout of telecommunications equipment cabinets and racks shall provide a minimum of 36 inch isle in front and behind equipment racks and cabinets which is clear of obstructions or equipment protrusions.

F. Within the various telecom rooms, coordinate rack locations and orientation to maintain required clearances including any equipment depths that may have to be accounted for. Some equipment, such as servers and UPS units may have special mounting requirements that need additional coordination.

3.3 IDENTIFICATION/LABELING

A. The Contractor shall be responsible for labeling all supplied communications equipment, in accordance with the guidelines as described herein.

B. Equipment racks/cabinets shall be labeled to indicate closet designation and sequential number within each closet.

C. On renovation projects where there already exists a numbering scheme, this contractor shall be responsible for maintaining and extending that numbering scheme as directed by the Owner.

D. All labeling and recording shall be approved by the Owner and the Engineer prior to application.
3.4 WARRANTY

A. The entire system as specified herein shall be guaranteed against defects in workmanship and materials for a period of three (3) years. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. The Installing Contractor shall provide the initial warranty service. The extended warranty shall be provided by the manufacturer. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

END OF SECTION 271100
PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The intent of this specification section is to cover the materials and installation of a structured cabling system and termination equipment as outlined herein and as detailed on the drawings. Work shall consist of:

1. Work area outlets including faceplates, jacks (voice, data, CATV, A/V), and labels. Boxes and conduit are being provided by Division 26 contractor.
2. Voice and data copper station cabling from work area outlets to telecommunications rooms including termination testing and labeling.
3. Voice and data work area equipment cords.
4. Voice and data horizontal cross-connect jumpers and patch cables including labeling.

1.2 SYSTEM DESCRIPTION

A. Voice and Data station cabling (copper) system shall consist of:

1. Workstation outlet jacks.
2. Voice and data station cabling as specified herein from each workstation outlet to the termination equipment located in the Main Telecom Room (ER).
3. Station Cable Termination Equipment in the ER.
4. Final connections of the station cabling at the workstation outlet jack and the termination equipment in the ER.
5. Cross connects / patch cable to connect work area outlets to backbone / network electronics.

B. All work shall be installed in compliance with the latest edition of the Commercial Building Telecommunications Wiring Standard EIA/TIA, ANSI, ICEA, BICSI Standards, applicable National Electric Code Sections, Ohio Building Codes.

1.3 CONTRACTOR QUALIFICATIONS

A. Work shall be performed by a BICSI certified Telecommunications Contractor that is properly certified in the cabling system being installed. Contractor’s requesting pre-approval from the Engineer to perform the work as specified in this section shall meet the following requirements:

B. The Contractor must have an on-staff, full time RCDD. The personnel assigned to project manager for this project must be a current RCDD in good standing.

C. The personnel assigned to project foreman at the project site must be a minimum BICSI Level II certified installer.

D. The Contractor must have at least one BICSI Level I certified installer in the daily work crew.
E. The Contractor must hold a current certification from the manufacturer of the proposed cabling system solution. This certification must be valid for both installation and testing and shall enable the Contractor to offer the full manufacturer’s product and applications warranties as specified herein.

F. Requests for consideration shall be sent to the Construction Manager/Architect/Engineer (by mail or fax) and shall include the following:

1. Copy of the BICSI RCDD certificate for the Contractor’s on-staff, full time project manager.
2. Copy of the BICSI Level I, II and III certificate(s) for the Contractor’s on-staff, full time installation personnel. Prior to commencement of work, the Contractor shall submit the resume of personnel assigned to the project. Any approval given during bidding shall be based upon the information submitted. Change in approved personnel prior to completion of the project shall be brought to the attention of the Engineer for review.
3. Copy of the Voice/Data System Manufacturers Approval Certificate indicating that the Contractor is a certified installer of the proposed voice and data Cabling System Solution.
4. It will not be the responsibility of the Engineer to recognize or respond to incomplete or incorrect requests.

G. It shall not be acceptable for any portion of the work specified herein to be performed by a sub-contractor unless such sub-contractor has been pre-approved by the Engineer in writing. Refer to following requirements:

1. The Engineer will respond in writing to applicants who meet the requirements of this specification or to the project’s construction manager. This response will serve as formal notice that the Contractor is approved for the listed project.
2. Contractors who have not received approval from the Engineer prior to issue of formal contracts will not be approved to perform the work outlined in this specification section regardless of their qualifications.

1.4 SHOP DRAWINGS

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

1.5 QUALIFICATIONS

A. Copy of current BICSI and manufacturers certifications. Certifications that are past the expiration date will not be accepted.

1.6 RELEVANT STANDARDS

A. The Structured Cabling Installation shall comply with the following at a minimum:

1. All local, state and national codes
2. The National Electric Code (NEC)
3. The National Electrical Safety Code (NESC)
4. Electronic Industries Alliance (EIA)/ Telecommunications Industry Association (TIA) 526, 568, 569, 598, 606, J-STD-607, 758 and all applicable and current Technical Service Bulletins (TSB).

1.7 RELATED SECTIONS

A. The following specification sections shall be deemed to be included in part or in whole and require close coordination to ensure total system interoperability and compatibility:

B. 27 11 00 – Communications Equipment Room Fittings

C. 27 15 43 – Communication Audio-Visual Horizontal Cabling

PART 2 - PRODUCTS

2.1 STRUCTURED CABLELING SYSTEM

A. The entire voice/data horizontal station cabling solution shall be a listed EIA/TIA cabling system solution from a single Manufacturer/Source as required by the Manufacturer/Source. Provide a listed Cabling System Solution utilizing cable/components from the following list of acceptable manufacturers:

1. Cable – Berk-Tek,
2. Components – Leviton,

B. Horizontal cabling systems shall be permanent link configuration for data.

C. Horizontal (station) cable shall be plenum rated. Horizontal cabling from the floor boxes to the TR shall be OSP rated.

D. Data station cabling shall be terminated utilizing EIA/TIA 568B standards.

E. Cables installed in underground conduits shall be wet label rated. Where wet label cables are required to feed floor boxes, the contractor shall transition cable back to plenum rated cable by providing “consolidation point” above ceiling consisting of Category rated 110 block and plenum enclosure and make transition from wet label cable to indoor plenum rated cable. Refer to drawings for locations with floor box outlets. Transition shall not affect system warranty.

2.2 DATA/VOICE STATION CABLE

A. Category 6, 4 twisted pair, non-shielded (UTP) station cable (capable of transmissions speeds in excess of 1.2 Gb/s and supporting IEEE 802.3ab Gigabit Ethernet) shall be used for serving data outlets. Cable shall be sequentially marked at 2 foot intervals. Color as selected by Owner.

B. Category 6A, 4 twisted pair, non-shielded (UTP) station cable shall be used for serving wireless access point outlets. Cable shall be sequentially marked at 2 foot intervals. Color as selected by Owner.
C. Each cable shall be a dedicated home run from the workstation outlet jack to the data
termination equipment in the local TR. Terminate cable at the workstation and at the TR
termination equipment as specified herein and as indicated on the drawings.

D. Cable shall be labeled at both ends to indicate patch panel and port served. Coordinate
labeling scheme with Owner and submit to Engineer for review.

2.3 WORKSTATION OUTLETS

A. Data/Voice Jacks

1. Served from Category 6 cable shall be Cat. 6 rated, 8 position, 8 wire flush mounted
modular jack (RJ-45). Equipment to be of manufacturer and series as required by
Specified Link/Channel Solution Warranty. Color as selected by Owner. Modular
mounting straps under duplex outlet faceplates shall not be acceptable.

2. For wireless access points served from Category 6A cable shall be Cat. 6A rated, 8
position, 8 wire flush mounted modular jack (RJ-45). Equipment to be of manufacturer
and series as required by Specified Link/Channel Solution Warranty. Color as selected by
Owner. Modular mounting straps under duplex outlet faceplates shall not be acceptable.

B. Outlet Components

1. Faceplates shall be modular and shall accept the approved voice/data and video jacks
including voice/data (RJ-11, RJ-45), Video (type F, type RCA, type BNC and S-Video),
Audio (type RCA) and fiber (type ST, SC, LC and MT-RJ). Faceplates and jacks shall be
by a single manufacturer. Equipment to be of manufacturer and series as required by
Specified Link/Channel Solution Warranty. Color as selected by Owner. Modular
mounting straps under standard outlet faceplates shall not be acceptable.

   a. It shall not be acceptable to utilize standard outlet style-line faceplates with modular
      mounting straps for the jacks. All jacks must mount directly to modular ports within
      the faceplate.

   b. Where standard faceplates are not available from the manufacturer for the full line of
      jacks designed at a particular location, the contractor shall be responsible for
      providing a custom punched and engraved faceplate to meet the application.

2. Outlets designated to serve wall phones shall be of a type that is designed to support a
wall mounted telephone. Equipment to be of manufacturer and series as required by
Specified Link/Channel Solution Warranty. Color as selected by Owner.

3. Outlets to be installed in floor boxes/pole-thru to be installed in faceplates, compatible
with floor box/poke-thru make/model and secured within floor box/poke-thru. The use of
loose or un-mounted jacks shall not be acceptable. Where floor box/poke-thru is
provided by others, coordinate during construction with floor box/poke-thru to determine
specific requirements for jacks and coverplate.

4. Each and every voice/data jack shall be labeled to corresponding patch panel and port.
Each and every audio/video and CATV jack shall be labeled to indicate function (audio
“L” and “R”, video, CATV, etc.). Coordinate labeling scheme with Owner. Labels shall
be computer generated on an adhesive media and attached to the workstation outlet.
Labels applied with pens or markers will not be acceptable.

5. Provide blank inserts for all unused ports.

6. Refer to drawings for arrangement of various workstation outlets including jack types and
quantities within each outlet type. All voice/data/video/audio and fiber jacks indicated in
the faceplate shall be deemed included in this specification unless specifically noted otherwise.

7. Outlet faceplates shall be stainless steel.

2.4 DATA TERMINATION EQUIPMENT

A. Twisted pair patch panels, rack mounted, Cat. 6 rated, 110 termination, RJ-45, multi-port (24 or 48) with rear cable management lacing bars. Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty. Provide quantity of patch panels as required by quantity of data station cable. Mount panels in data racks in each TR. Each panel shall be fully loaded. Provide labeling for each connected port as coordinated with Owner.

B. For wireless access points, twisted pair patch panels, rack mounted, Cat. 6A rated, 110 termination, RJ-45, multi-port (24 or 48) with rear cable management lacing bars. Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty. Provide quantity of patch panels as required by quantity of data station cable. Mount panels in data racks in each TR. Each panel shall be fully loaded. Provide labeling for each connected port as coordinated with Owner.

C. Provide quantity of copper patch panels to accommodate complete termination of all installed copper station cables plus an additional 20 percent spare capacity.

2.5 STATION CABLE TERMINATION ASSIGNMENTS

A. Refer to the drawings for assignment of room station cabling to the respective TR termination equipment.

2.6 PATCH CABLES

A. This contract shall be responsible for providing all required patch cables to make a complete and fully functioning network. The following patch cables requirements are considered part of these specifications:

1. Data Station (copper) at Workstation – Provide a nominal 12 feet patch cable with every workstation jack to match the EIA/TIA channel configuration of the cabling system. Coordinate the patch cable length and color with the Owner by establishing specific color types and various cable lengths throughout the installation. The Owner may requests various lengths at various outlets depending upon the field conditions and the locations of the equipment which utilizes any given jack.

2. Data Station (copper) at TR – Provide a nominal 7 foot patch cable with every patch panel port to match the EIA/TIA channel configuration of the cabling system. Coordinate the patch cable length and color with the Owner by establishing specific color types and various cable lengths throughout the installation. The Owner may requests various lengths at various patch panel ports depending upon the field conditions and the locations of the equipment which utilizes any given port.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION
A. Backboard mounted wiring connecting blocks shall be mounted such that the top of block is no more than 72 inches from the floor and the bottom of lowest block is no lower than 30 inches from the floor.

B. Cross connects / patch cables from voice backbone cable to voice station cables shall be furnished / provided by this Contractor, installed by 27 21 00 Contractor. Patch cables from data backbone and data station cable patch panels to network electronic equipment shall be furnished / provided by this Contractor, installed by Division 27 21 00 Contractor.

C. Refer to drawings for quantity and arrangement of voice/data/technology outlets including jacks and cabling.

D. Make all telephone and data terminations at TR termination equipment and at each workstation outlet jack utilizing a tool appropriate for the equipment as recommended by the equipment manufacturer.

E. Coordinate color requirements for all jacks, station cables, patch panels, patch cables, etc. with Owner / Engineer. Color coding shall be consistent for all like equipment.

F. Delivery of all loose equipment which is to be turned over to Owner shall be carefully coordinated and scheduled with Owner prior to shipment.

3.2 WIRING INSTALLATION

A. Voice and data station cable shall not exceed the EIA/TIA maximum lengths for the specified Category rating. The contractor shall be responsible for verifying adequate cable pathways to limit cable lengths prior to installation. Where existing or designed pathways do not allow for compliance to distance limitations for voice and data cabling, the contractor shall provide alternate pathway routes to the Engineer for review.

B. Interior (raised floor) - All voice/data/CATV station cables shall be run in conduit from outlet down to below raised access floor, extended beneath access floor to MER as indicated on drawings and specifications. All cabling shall be neatly bundled, dressed and organized below raised floor. The contractor will be responsible for all cable management required to support cables per standards between installed fixed raceways (conduit, cable tray, wireways, etc.).

C. Interior (overhead) - All voice/data/CATV station cables shall be run in conduit from outlet to above accessible ceiling space, extended from a combination of conduit/suspended cable management system to ER as indicated on drawings and specifications. All cabling shall be run parallel or perpendicular to building lines. The contractor will be responsible for all cable management required to support cables per standards between installed fixed raceways (conduit, cable tray, wireways, etc.).

D. The drawings do not indicate specific routes for telecommunications cables. The Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental cable management pathways and systems so that all structured cabling adhere to specific codes and standards specifically developed for the installation of such cables. Where the use of existing cable management systems and pathways would cause the structured cable system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc, the Contractor shall
be responsible for developing alternative pathways and shall include all labor and material for doing so within the scope of this work.

E. In areas where there is not an installed raceway system (conduits or cable tray) and a cable support system is required, this contract shall be responsible for providing a Cable Management System. Cable management system shall provide support no more than 5 feet on center. Where cables are installed open wired through the use of cable management systems, they shall be installed such that there is a minimum sag of 4 inches for every 4 foot of horizontal run. Cable pathways shall provide the following minimum clearances (parallel or perpendicular):

1. Motors and transformers – 48 inches
2. Conduit and cable used for electrical power distribution – 12 inches
3. Fluorescent lighting – 5 inches
4. Power lines up to 2kVA – 5 inches
5. Power lines over 5kVA – 24 inches
6. Hot water/steam lines - Bare – 18 inches, Insulated – 6 inches

F. Cable management system shall be secured to building structure utilizing manufactured approved methods and hardware.

G. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building’s structure such as beams, joists, etc. to hang cable from will not be acceptable.

H. Each voice and data jack shall be wired with a dedicated home run. Each voice and data jack shall be identified. The jacks shall be labeled on the faceplate. Station cables shall be labeled at TR termination point with corresponding workstation outlet jack number.

I. Voice and data cables shall be handled and installed with extreme care. Twisted pairs shall be untwisted less than .5 inch at terminations for Cat, 5e, Cat. 6. Tie wraps shall loosely hold cables; do not overtighten. Cables shall have sweeping bends and shall have a maximum bending radius at any point in the installation of not less than 4 times the outer diameter of the cable. The cable manufacturer’s recommended bending radius and maximum pulling tensions shall be strictly adhered and shall not be exceeded. Failure to comply will result in the removal and replacement of affected cable at no additional cost to the Owner.

J. Voice and data horizontal station cable shall not exceed the EIA/TIA guidelines for LINK distances. The permanent LINK shall be as defined in the EIA/TIA standards as the distance from the workstation outlet jack to the TR termination equipment patch panel/cross-connect port.

K. Provide adequate cable slack at each workstation outlet and the IDF/MDF termination equipment as follows:

1. Workstation outlet
   a. 12 inches of copper cable slack.

L. Where cables are installed in conduit, the conduit system shall conform to the following:
1. No section of conduit shall be longer than 100 feet between pulling points.
2. No more than two 90 deg. Bends in a section of conduit between pulling points.
3. Each section of conduit shall be labeled for length, destination closet and origination closet.
4. Refer to EIA/TIA 569-A for specific conduit and pull box requirements.

M. At voice termination equipment at TR racks/backboards, voice backbone and station cables shall be terminated following the standard telephone color code unless otherwise indicated.

N. All cabling installed in underground conduit installations shall be outdoor rated cables, acceptable for use by the manufacturer in underground applications.

3.3 TELECOMMUNICATIONS ROOMS

A. The lay-out of the telecommunications rooms as depicted on the drawings shall be utilized as a general guide for bidding purposes. The final room layout shall be carefully coordinated with input from the Owner and from other trades with equipment and/or cabinets to be placed in the room. Final configuration of telecom rooms shall be submitted to Engineer as a coordination drawing with information from all other trades occupying the same room for review prior to permanent mounting of equipment or termination of cabling.

B. Coordinate lay-out of telecom rooms to avoid placing telecommunications equipment and cabinets under water piping (other than sprinkler heads) or HVAC units.

C. Coordinate lay-out of telecom rooms with electrical plans and locations of electrical outlets.

D. Lay-out of telecommunications equipment cabinets and racks shall provide a minimum of 36 inch isle in front and behind equipment racks and cabinets which is clear of obstructions or equipment protrusions.

E. Within the various telecom rooms, coordinate rack locations and orientation to maintain required clearances including any equipment depths that may have to be accounted for. Some equipment, such as servers and UPS units may have special mounting requirements that need additional coordination.

3.4 IDENTIFICATION/LABELING

A. The Contractor shall be responsible for labeling all supplied communications equipment, cable, etc. in accordance with the guidelines as described herein. The end of each cable, each jack, patch panel, cross-connect and rack/backboard shall be identified and permanently recorded on 8.50 X 11 sheets attached to each rack/backboard.

B. No labeling shall be applied until the final building signage package has been approved and incorporated.

C. Each cable, jack cross-connect and patch panel shall be labeled at every location where they are administered per TIA/EIA-606.

D. Both ends of data and telephone system cabling shall be tagged and identified utilizing a permanent cable marking system or other system as approved by the Owner / Engineer.
DYMO style labels, cloth or plastic “numbers” or hand written labels WILL NOT BE ACCEPTED.

E. Station Cable, Room side - Utilize a three (3) syllable labeling scheme as follows:

1. Sample label for station cable / jack “TR5-01-33” (read as: Station cable, fed from TR-05, terminated in patch panel 01, terminated on jack number thirty three).
2. First syllable shall consist of a numeral following the letters “TR”. The numeral shall indicate the wiring closet “TR”, the jack and cable feed from (2 would be “TR-02”, 7 would be “TR-07”, etc.).
3. The second syllable shall consist of a numeral. The numeral shall indicate which patch panel in the wiring closet the cable is connected to.
4. The third syllable shall consist of a numeral to indicate which jack in the patch panel the cable is connected to.
5. Labels to be applied within 6 inches of termination.

F. Station Cable, Closet side - Utilize a three (3) syllable labeling scheme as follows:

1. Sample label for station cable / jack “143-01-33” (read as: Station cable, located in room 143, terminated in patch panel 01, terminated on jack number thirty three).
2. First syllable shall consist of a numeral. The numeral shall indicate the architectural room number of the room the jack is located in.
3. The second syllable shall consist of a numeral. The numeral shall indicate which patch panel in the wiring closet the cable is connected to.
4. The third syllable shall consist of a numeral to indicate which jack in the patch panel the cable is connected to.
5. Labels to be applied within 6 inches of termination.

G. Patch panels to have panel # / port # / room number for each terminated cable.

H. This contractor shall be responsible for maintaining and extending that numbering scheme as directed by the Owner.

I. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.5 TESTING GENERAL

A. The Contractor shall be responsible for testing all installed structured cables including:

1. Voice and data station

B. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted. All final test reports shall utilize the field installed labels at each outlet for the test of the corresponding outlet. Test reports which contain temporary generic or incorrect labels will not be accepted.

C. The Contractor shall be responsible for testing of all installed data station cables, of all installed voice station cables.
D. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted.

E. Tests shall be witnessed by Architect / Engineer / Owner and shall be monitored by a recorder.

F. System testing shall be performed with final test results turned over to the Owner prior to acceptance of the system. Missing or incomplete test results will not be reviewed and the system will not be commissioned by the Owner / Architect / Engineer.

G. Instruments and labor required for tests shall be furnished by the Contractor. All system test equipment shall be approved by the Owner/ Architect / Engineer prior to application.

H. The Owner / Architect / Engineer reserve the right to spot test 5 percent of the installed cabling plant to verify documented test results. Where the Owner / Architect / Engineer have determined that the installed cable plant does not agree with the documented test results, the contractor shall be responsible for re-testing the installed voice/data/fiber cabling plant and revising/updating all test documentation as required.

I. Instruments required for tests shall be furnished by the Contractor.

3.6 TESTING VOICE/DATA STATION

A. Each user voice and data station cable system shall be electronically verified. The voice / data system shall be tested in the permanent LINK (from the workstation outlet jack to the termination equipment patch panel port/cross-connect port) configuration. Each voice and data permanent LINK shall meet or exceed the EIA / TIA Solution Manufacturer’s specified parameters of components within each permanent LINK. The respondent’s test plan will specify the procedures for the following tests:


2. Length - Each cable pair is TDR scanned to determine each pair's individual length. The test results are recorded in feet. The EIA/TIA specification limit of 90 meters is used to qualify the overall length of each circuit.

3. Attenuation - This test measures the loss or attenuation that each pair exhibits to determine whether or not high speed data packets will be discernible at their destination.

4. Induced Noise - The noise test measures the presence of external signals at three critical frequency ranges. The test results of each pair are recorded. The three ranges to be tested are as follows:
   a. Low Band (10Hz-150 KHz)
   b. Mid Band (150 KHz-16 Mhz)
   c. High Band (16 Mhz-100 Mhz)

5. Resistance - This test individually measures loop resistance on each of the four pairs. Resistance is checked to see that it is within manufacturer's tolerance limits for the circuit's length and gauge.

6. Near End Crosstalk (NEXT) - The NEXT of each pair is measured as impacted by every other possible pair combination. The test sweeps the specification bandwidth to determine the worst case NEXT frequency for a particular pair. Both the NEXT value and occurring frequency are documented for each possible pair combination. The order of testing is as follows:
   a. Pair 1 & 2 to Pair 3 & 6
b. Pair 1 & 2 to Pair 4 & 5  
c. Pair 1 & 2 to Pair 7 & 8  
d. Pair 3 & 6 to Pair 4 & 5  
e. Pair 3 & 6 to Pair 7 & 8  
f. Pair 4 & 5 to Pair 7 & 8  

7. Test for Return Loss, Delay, Delay Skew, NEXT, PSNEXT, ELFEXT, PSELFEXT, ACR and PSACR shall be as required by the latest edition of EIA / TIA Level III tests and the latest edition of the Manufacturer’s/Source’s Channel Solution Program to verify adherence to these specifications of the cabling system.

8. All tests shall pass without any “marginals”.

B. The contractor shall provide independent 3rd party testing of 10 percent of all installed voice and data outlets. This independent testing shall be assembled in a separate binder and submitted along with the test reports in the O&M manual. Significant discrepancies in test results between the independent testing and the Contractor’s testing shall be addressed by the Contractor to the Engineer and the Owner’s satisfaction.

C. Provide a hard copy of the test results of each and every voice and data channel tested to the Owner. Documentation shall be in the following format:

1. Cable ID  
2. Test parameter used  
3. Date of test  
4. Length  
5. Pass / Fail result  
6. Provide an electronic copy of the LINK/CHANNEL testing done with a cable analyzer and saved on CD Rom. Test results saved in a proprietary file type shall be included with software for reading the test results on the Owner’s computer system. Test results shall be verified by the Owner as part of the acceptance procedure. Provide with hard copies and a CD containing the electronic files with the O&M Manuals.

3.7 SYSTEM ACCEPTANCE REQUIREMENTS

A. The contractor shall submit printed test results per the testing specification requirements for review by the Engineer/Owner prior to system acceptance. Any cable components that have not passed the full requirements of the system testing shall be replaced and re-tested at the contractor’s expense prior to system acceptance.

3.8 AS-BUILT DOCUMENTATION

A. Refer to Section 27 05 01 for submittal requirements.

B. Technology drawings updated with final as-Built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.

1. AutoCAD architectural floor plans at a scale of 0.125 inches =1 foot-0 inches on 30x42 size sheets showing the location and label of each workstation outlet, IDF closet and MDF closet. Labeling shall match the labeling installed in the field. These drawings shall be as-built conditions.
2. AutoCAD architectural floor plans at a scale of 0.25 inches = 1 foot-0 inches on 30x42, 24x36 size sheets showing the telecommunications equipment layout in each IDF closet and the MDF closet. This layout shall include the racks, backboards, cable tray, conduit sleeves, 120V power, etc. Each piece of equipment where labeled in the field shall have the corresponding label on these plans. These drawings shall be as-built conditions.

3. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

4. Rack elevations for all systems with rack mounted equipment. The details shall indicate each piece of telecommunications equipment in each rack including equipment labels such as patch panel, wire management panel, blank panel, space, etc. Each port of each patch panel shall be fully labeled to match the labeling installed in the field.

C. Cable Test Results - Provide bound documents of all cable test results in printed format and in software version on a compact disc. Software version must include any required reader software where file formats are proprietary or non-standard text files. Cable test results shall be organized by media (fiber, copper) and by closet. Information must be included in O&M Manuals.

1. Copper Test Results
   a. Documentation shall be in the following format:
      1) Cable ID
      2) Test parameter used
      3) Date of test
      4) Length
      5) Pass / Fail result

D. The entire structured cabling system as specified herein shall be guaranteed against defects in workmanship and materials as described herein. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

3.9 WARRANTY

A. The entire structured cabling system as specified herein shall be guaranteed against defects in workmanship and materials. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. The Installing Contractor shall provide the initial warranty service. The extended warranty shall be provided by the manufacturer. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

B. The entire voice / data station cabling system warranty shall be a listed cabling system solution from a single Manufacturer / Source. The system shall carry an industry standard, performance based warranty, by the manufacturer, for a period of at least 20 years on the horizontal cabling; including patch panels, patch cables, terminations and labor. The remaining portions of the system shall be warranted for a period of three (3) years from date of substantial completion.

C. The warranty shall not be affected by the use of power over Ethernet on any or all of the links.

D. The warranty shall not be affected by selected links required to have transition points from OSP to indoor where serving underground conduits to floor boxes. It shall be the Contractors
responsibility to provide manufacturer’s approved transition points to maintain system warranty on any affected runs.

3.10 CERTIFICATION

A. The contractor shall be responsible for filing all required paperwork on behalf of the Owner to acquire the system performance warranty and certification as outlined in the Structured Cabling System Solution.

END OF SECTION 271513
SECTION 271533 - COMMUNICATIONS COAXIAL HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The intent of this specification section is to cover the materials and installation of a structured cabling system and termination equipment as outlined herein and as detailed on the drawings. Work shall consist of:

1. Work area outlets including faceplates, jacks (voice, data, CATV, A/V), and labels. Boxes and conduit are being provided by Division 26 Contractor.
2. Cable TV broadband RF coaxial station cabling from work area outlets to telecommunications rooms including termination, testing and labeling. Broadband CATV distribution equipment including splitters, taps, amplifiers, etc. is being provided under Section 274117.

1.2 SYSTEM DESCRIPTION

A. Broadband CATV station cabling (coaxial) system shall consist of:

1. Workstation outlet jacks.
2. Coaxial station cabling as specified herein from each workstation outlet to the termination equipment located in the Local Telecom Closet (TR-0X) or the Main Telecom Room (MTR).
3. Station Cable Termination Equipment in each TR.
4. Broadband CATV distribution equipment including splitters, taps, amplifiers, etc. is being provided under Section 274117.
5. Testing and labeling.

1.3 QUALITY ASSURANCE

A. All work shall be installed in compliance with the latest edition of the Commercial Building Telecommunications Wiring Standard EIA/TIA, ANSI, ICEA, BICSI Standards, applicable National Electric Code Sections, Ohio Building Codes.

1.4 SHOP DRAWINGS

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

1.5 RELEVANT STANDARDS

A. The structured cabling Installation shall comply with the following at a minimum:

1. All local, state and national codes
2. The National Electric Code (NEC)
3. The National Electrical Safety Code (NESC)
4. Electronic Industries Alliance (EIA)/ Telecommunications Industry Association (TIA) 526, 568, 569, 598, 606, J-STD-607, 758 and all applicable and current Technical Service Bulletins (TSB).

PART 2 - PRODUCTS

2.1 STRUCTURED CABELING SYSTEM

A. The entire coaxial horizontal station cabling solution shall match the voice/data cabling system solution from a single manufacturer/source as required by the manufacturer/source. Provide a listed Cabling System Solution utilizing cable/components from the following list of acceptable manufacturers:

1. ADC/Krone, Tyco Electronics (TE/CommScope), Systimax, Avaya, Belden (CDT), Berk-Tek, Commscope, Draka, General BICC, Mohawk, 3M, ICC.

B. Horizontal (station) cable shall be plenum rated.

2.2 COAXIAL BROADBAND STATION CABLE

A. Coaxial cable shall be 75 ohms nominal impedance and shall be marked with the manufacturer's name. It shall be sweep tested by the manufacturer before shipping and be certified by the tester as such on a tag on each reel. No discontinuity shall exist within TV frequency bands 54-216 MHz and 470-890 MHz on the cable. The outer jacket shall be of the non-contaminating type. No cable which shows bruises or shipping damages shall be installed in the system, nor shall any splices or connectors be installed in conduit or any inaccessible place.

B. Video Station Cable: Provide dual / quad shielded, plenum rated, station cable from each video outlet to distribution equipment in local TR as indicated on drawings:

1. 0 – 135 feet – utilize RG-6.
2. 135 feet – 300 feet utilize RG-11.
3. Where a room contains both a technology outlet and a video/projector outlet, the incoming video cable shall be connected to a local tap/splitter mounted at the room. Provide additional cables from the tap/splitter to each outlet within the room as required to provide forward and return path video from each outlet.

C. Coaxial Station cable shall be run to location in TR where CATV broadband distribution equipment is to be located. Coordinate with Section 27 41 17 contractor. Provide adequate slack in cable.

D. Termination of cable shall be with radial crimp “F” connectors specifically listed for use with the supplied cable. Hex crimp connectors will not be acceptable. Terminators shall be screw type.

E. All cable as manufactured by Comm Scope, West Penn, Belden, Carol.

2.3 WORKSTATION OUTLETS

A. Video (CATV) Jacks
1. Type “F” female couplers for CATV outlets. Jacks shall be same manufacturer as workstation voice and data jacks.

B. Outlet Components

1. Faceplates shall be modular 6 port and shall accept the approved voice/data and video jacks including voice/data (RJ-11, RJ-45), Video (type F, type RCA, type BNC and S-Video), Audio (type RCA) and fiber (type ST, SC, LC and MT-RJ). Faceplates and jacks shall be by a single manufacturer. Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty. Color as selected by owner.
   a. It shall not be acceptable to utilize standard outlet style-line faceplates with modular mounting straps for the jacks. All jacks must mount directly to modular ports within the faceplate.
   b. Where standard faceplates are not available from the manufacturer or the full line of jacks designed at a particular location, the contractor shall be responsible for providing a custom punched and engraved faceplate to meet the application.

2. Each and every jack shall be labeled to corresponding patch panel and port. Each and every audio/video and CATV jack shall be labeled to indicate function (audio “L” and “R”, video, catv, etc.). Coordinate labeling scheme with Owner. Labels shall be computer generated on an adhesive media and attached to the workstation outlet. Labels applied with pens or markers will not be acceptable.

3. Outlets to be installed in floor boxes / poke-thru’s to be installed in faceplates, compatible with floor box / poke-thru make / model and secured within floor box/poke-thru. The use of loose or un-mounted jacks shall not be acceptable. Where floor box / poke-thru is provided by others, coordinate during construction with floor box / poke-thru to determine specific requirements for jacks and coverplate.

4. Provide blank inserts for all unused ports.

5. Refer to drawings for arrangement of various workstation outlets including jack types and quantities within each outlet type. All voice/data/video and fiber jacks indicated in the faceplate shall be deemed included in this specification unless specifically noted otherwise.

6. Outlet faceplates shall be stainless steel. Where manufacturer does not provide a full compliment of voice/data and AV modules as required by design configurations, the contractor shall be responsible for utilizing a custom punch plate including all associated costs.

7. Outlet faceplates shall be stainless steel

2.4 TR TERMINATION EQUIPMENT

A. Cable ends to be terminated with male “F” type connectors and provided with adequate slack for connection to Broadband CATV distribution equipment provided under section 27 41 17.

B. Cables to be connected onto 12/24/48 port patch panels with type “F” female couplers.

2.5 STATION CABLE TERMINATION ASSIGNMENTS

A. Refer to the drawings for assignment of room station cabling to the respective TR termination equipment.
3.1 GENERAL INSTALLATION

A. Refer to drawings for quantity and arrangement of outlets including jacks and cabling.

B. Make all terminations at TR termination equipment and at each workstation outlet jack utilizing a tool appropriate for the equipment as recommended by the equipment manufacturer.

C. Coordinate color requirements for all jacks, station cables, patch panels, patch cables, etc. with Owner / Engineer. Color coding shall be consistent for all like equipment.

D. Delivery of all loose equipment which is to be turned over to owner shall be carefully coordinated and scheduled with owner prior to shipment.

3.2 WIRING INSTALLATION

A. Interior - All CATV station cables shall be run in conduit / surface raceway from outlet to above accessible ceiling/ in conduit from outlet to nearest section of corridor cable tray/ extended from suspended cable management system out to nearest section of corridor cable tray/in conduit from outlet to local TR or ER extended via corridor cable tray and/or cable management system to local TR or ER as indicated on drawings and specifications. All cabling shall be run parallel or perpendicular to building lines.

B. The drawings do not indicate specific routes for telecommunications cables. The Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental cable management pathways and systems so that all structured cabling adhere to specific codes and standards specifically developed for the installation of such cables. Where the use of existing cable management systems and pathways would cause the structured cable system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc., the Contractor shall be responsible for developing alternative pathways and shall include all labor and material for doing so within the scope of this work.

C. In areas where there is not an installed raceway system (conduits or cable tray) and a cable support system is required, this contract shall be responsible for providing a cable management system. Cable management system shall provide support no more than 5 feet on center. Where cables are installed open wired through the use of cable management systems, they shall be installed such that there is a minimum sag of 4 inches for every 4 foot of horizontal run. Cable pathways shall provide the following minimum clearances (parallel or perpendicular):

1. Motors and transformers – 48 inches
2. Conduit and cable used for electrical power distribution – 12 inches
3. Fluorescent lighting – 5 inches
4. Power lines up to 2kVA – 5 inches
5. Power lines over 5kVA – 24 inches
6. Hot water/steam lines - Bare –18 inches, Insulated – 6 inches
D. Cable management system shall be secured to building structure utilizing manufactured approved methods and hardware.

E. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building’s structure such as beams, joists, etc. to hang cable from will not be acceptable.

F. Each jack shall be wired with a dedicated home run. Each jack shall be identified. The jacks shall be labeled on the faceplate. Station cables shall be labeled at TR termination point with corresponding workstation outlet jack number.

G. Cables shall have sweeping bends and shall have a maximum bending radius at any point in the installation of not less than 4 times the outer diameter of the cable. The cable manufacturer’s recommended bending radius and maximum pulling tensions shall be strictly adhered and shall not be exceeded. Failure to comply will result in the removal and replacement of affected cable at no additional cost to the Owner.

H. Provide adequate cable slack at each workstation outlet and the IDF/MDF termination equipment as follows:
   1. Workstation outlet - 12 inches slack.

I. Where cables are installed in conduit, the conduit system shall conform to the following:
   1. No section of conduit shall be longer than 100 feet between pulling points.
   2. No more than two 90 deg. Bends in a section of conduit between pulling points.
   3. Each section of conduit shall be labeled for length, destination closet and origination closet.
   4. Refer to EIA/TIA 569-A for specific conduit and pull box requirements.

J. All cabling installed in underground conduit installations shall be outdoor rated cables, acceptable for use by the manufacturer in underground applications.

3.3 TELECOMMUNICATIONS ROOMS

A. The lay-out of the telecommunications rooms as depicted on the drawings shall be utilized as a general guide for bidding purposes. The final room layout shall be carefully coordinated with input from the owner and from other trades with equipment and/or cabinets to be placed in the room. Final configuration of telecom rooms shall be submitted to Engineer as a coordination drawing with information from all other trades occupying the same room for review prior to permanent mounting of equipment or termination of cabling.

B. Provide ladder rack in telecommunications rooms in configurations as required by final room layout.

C. Coordinate layout of telecom rooms to avoid placing telecommunications equipment and cabinets under water piping (other than sprinkler heads) or HVAC units.

D. Coordinate layout of telecom rooms with electrical plans and locations of electrical outlets.
E. Layout of telecommunications equipment cabinets and racks shall provide a minimum of 36 inch aisle in front and behind equipment racks and cabinets which is clear of obstructions or equipment protrusions.

F. Within the various telecom rooms, coordinate rack locations and orientation to maintain required clearances including any equipment depths that may have to be accounted for. Some equipment, such as servers and UPS units may have special mounting requirements that need additional coordination.

3.4 IDENTIFICATION/LABELING

A. The Contractor shall be responsible for labeling all supplied communications equipment, cable, etc. in accordance with the guidelines as described herein. The end of each cable, each jack, patch panel, cross-connect and rack/backboard shall be identified and permanently recorded on 8.50 X 11 sheets attached to each rack/backboard.

B. Each cable, jack and patch panel shall be labeled at every location where they are administered per TIA/EIA-606.

C. Cable shall be identified and labeled on the blocks and patch panels. Both ends of data and telephone system cabling shall be tagged and identified utilizing a permanent cable marking system or other system as approved by the Owner / Engineer. DYMO style labels, cloth or plastic “numbers” or hand written labels WILL NOT BE ACCEPTED.

D. Station Cable, Room side - Utilize a two (2) syllable labeling scheme as follows:

   1. Sample label for station cable / jack “TR5-01” (read as: Station cable, fed from TR-05, cable #01).
   2. First syllable shall consist of a numeral following the letters “TR”. The numeral shall indicate the wiring closet “TR”, the jack and cable feed from (2 would be “TR-02”, 7 would be “TR-07”, etc.).
   3. The second syllable shall consist of a sequential numeral for cables in each closet.

E. Station Cable, Closet side - Utilize a two (2) syllable labeling scheme as follows:

   1. Sample label for station cable / jack “143-01” (read as: Station cable, located in room 143, cable #01).
   2. First syllable shall consist of a numeral. The numeral shall indicate the architectural room number of the room the jack is located in.
   3. The second syllable shall consist of a sequential number for cables from each closet.

F. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.5 TESTING GENERAL

A. The Contractor shall be responsible for testing all installed Structured cables including:

   1. Broadband coaxial station
B. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted. All final test reports shall utilize the field installed labels at each outlet for the test of the corresponding outlet. Test reports which contain temporary generic or incorrect labels will not be accepted.

C. The Contractor shall be responsible for testing 10 percent of all installed coaxial station cables. Where required to test a percentage of each cable type, the contractor shall choose the cables to test in such a manner as to provide a good cross sectional representation of the entire installed cabling plant. In such a manner, the Contractor shall avoid choosing all of the test cables from a single location or termination room.

D. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted.

E. Tests shall be witnessed by Architect / Engineer / Owner and shall be monitored by a recorder.

F. System testing shall be performed with final test results turned over to the Owner prior to acceptance of the system. Missing or incomplete test results will not be reviewed and the system will not be commissioned by the Owner / Architect / Engineer.

G. Instruments and labor required for tests shall be furnished by the Contractor. All system test equipment shall be approved by the Owner/ Architect / Engineer prior to application.

H. The Owner / Architect / Engineer reserve the right to spot test 5 percent of the installed cabling plant to verify documented test results. Where the Owner / Architect / Engineer have determined that the installed cable plant does not agree with the documented test results, the contractor shall be responsible for re-testing the installed voice/data/fiber cabling plant and revising/updating all test documentation as required.

I. Instruments required for tests shall be furnished by the Contractor.

3.6 TESTING CATV BROADBAND STATION

A. System shall be tested end-to-end complete by and a certificate of inspection shall be furnished by a qualified manufacturer's representative or equipment vendor; submit report to the Architect.

B. This Contractor shall provide the following tests with results to indicate conformance with the specifications at each outlet:

1. Cable Continuity
2. Nominal Impedance
3. TDR test for determining final cable length.

C. In addition, each cable shall be tested prior to installation for impedance, time domain and structural return loss.

D. All test equipment and qualified labor shall be included in this contract. The installer must be proficient in the use of all required test equipment.
3.7 SYSTEM ACCEPTANCE REQUIREMENTS

A. The contractor shall submit printed test results per the testing specification requirements for review by the Engineer/Owner prior to system acceptance. Any cable components that have not passed the full requirements of the system testing shall be replaced and re-tested at the contractor’s expense prior to system acceptance.

3.8 AS-BUILT DOCUMENTATION

A. Refer to Section 27 05 01 for submittal requirements.

B. Copies of all approved shop drawings with the Engineer’s stamp.

C. Cable Test Results - Provide bound documents of all cable test results in printed format and in software version on a compact disc. Software version must include any required reader software where file formats are proprietary or non-standard text files. Cable test results shall be organized by media (fiber, copper) and by closet. Information must be included in O&M Manuals.

D. The entire structured cabling system as specified herein shall be guaranteed against defects in workmanship and materials as described herein. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

3.9 WARRANTY

A. The entire structured cabling system as specified herein shall be guaranteed against defects in workmanship and materials for a period of three (3) years. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. The Installing Contractor shall provide the initial warranty service. The extended warranty shall be provided by the manufacturer. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

END OF SECTION 271533
PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The intent of this specification section is to cover the materials and installation of a structured cabling system and termination equipment as outlined herein and as detailed on the drawings. Work shall consist of:

1) Work area outlets including faceplates, jacks (voice, data, CATV, A/V), labels. Boxes and conduit are being provided by Div 26 contractor.
2) Audio/Video cabling between local A/V outlets, A/V equipment and A/V distribution systems including termination, testing and labeling.
3) Audio/Video cabling from local outlets to central patch room including termination, testing and labeling.
4) Audio/Video patch cables at both work area outlets and Audio/Visual equipment.

1.2 SYSTEM DESCRIPTION

A. Local Audio and Video Cabling System

1) Workstation outlets and cabling consisting of:
   a) Digital Video (DVI, HDMI)
   b) Component Video (RGBHV)
   c) Audio
   d) RS-232 Control

2) Local audio and video cable terminations on the technology outlet, video outlet, and other miscellaneous A/V outlets.

3) Testing and labeling.

1.3 QUALITY ASSURANCE

A. All work shall be installed in compliance with the latest edition of the Commercial Building Telecommunications Wiring Standard EIA/TIA, ANSI, ICEA, BICSI Standards, applicable National Electric Code Sections, Ohio Building Codes.

1.4 SHOP DRAWINGS

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.
1.5 RELEVANT STANDARDS

A. The Structured Cabling Installation shall comply with the following at a minimum:
   1) All local, state and national codes
   2) The National Electric Code (NEC)
   3) The National Electrical Safety Code (NESC)
   4) Electronic Industries Alliance (EIA)/ Telecommunications Industry Association (TIA) 526, 568, 569, 598, 606, J-STD-607, 758 and all applicable and current Technical Service Bulletins (TSB).

PART 2 - PRODUCTS

2.1 STRUCTURED CABLELING SYSTEM

A. Modular Components – to match voice/data station solution.

B. Horizontal (station) cable shall be plenum rated.

2.2 LOCAL VIDEO AND AUDIO CABLE

A. Digital Video

   1) Field Cabling – STP.
   2) Patch cabling – HDMI: The one-piece, connectorized HDMI cables shall be high-speed, category 6 cables that are certified to support speeds of 340 MHz to 1.2 Gbps and 1080p/60, comply with HDMI 1.4 specifications and shall be terminated with Type A connectors. Provide cables that are tested and verified to meet these specifications for the specific length of cable provided.
      a) Physical characteristics:
         (1) 24k gold-plated connectors
         (2) 24 AWG high-purity, oxygen-free conductors
         (3) High-density triple shielding for rejection of EMI and RFI
         (4) UL Listed, CL2P, CL3P and CMP certified

B. Analog Video

   1) High Resolution Component/RGBHV – 5 conductor, mini-coax, 26 gauge, 75 ohm.

C. Audio Cable

   1) Line level - Stranded 20AWG copper twisted, shielded pair with drain wire homerun to the equipment rack.
   2) Speaker level - Stranded 16AWG copper twisted pair from the equipment rack to the loudspeaker(s).
D. Control Cable

1) RS-232 - High performance, low capacitance serial control cable, 2-twisted pair #24 AWG tinned copper with overall outer aluminum polyester foil shield and a tinned copper drain wire.

2) IR Control – 2 conductor #22AWG

3) Relay Control – 2 conductor #22AWG.

2.3 WORKSTATION OUTLETS

A. Local Audio/Video Jacks

1) Local Audio/Video jacks shall be by same manufacturer as workstation voice & data jacks.

2) Component/RGBHV – 15 pin HD field terminate solder type or 5 BNC female mini break-out to 15 pin HD coupler. Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty. Color as selected by Owner.

3) Stereo Audio – Type RCA, female. Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty. Color as selected by Owner.

B. Outlet Components

1) Faceplates shall be modular 6 port and shall accept the approved voice/ data and video jacks including voice/data (RJ-11, RJ-45), Video (type F, type RCA, type BNC and S-Video), Audio (type RCA) and fiber (type ST, SC, LC and MT-RJ). Faceplates and jacks shall be by a single manufacturer. Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty. Color as selected by Owner.

   a) It shall not be acceptable to utilize standard outlet style-line faceplates with modular mounting straps for the jacks. All jacks must mount directly to modular ports within the faceplate.

   b) Where standard faceplates are not available from the manufacturer or the full line of jacks designed at a particular location, the contractor shall be responsible for providing a custom punched and engraved faceplate to meet the application.

2) Each and every jack shall be labeled to corresponding patch panel and port. Each and every audio/video and CATV jack shall be labeled to indicate function (audio “L” and “R”, video, catv, etc.). Coordinate labeling scheme with Owner. Labels shall be computer generated on an adhesive media and attached to the workstation outlet. Labels applied with pens or markers will not be acceptable.

3) Outlets to be installed in floor boxes/poke-thru’s to be installed in faceplates, compatible with floor box / poke-thru make / model and secured within floor box / poke-thru. The use of loose or un-mounted jacks shall not be acceptable. Where floor box / poke-thru to determine specific requirements for jacks and coverplate.
4) Provide blank inserts for all unused ports.

5) Refer to drawings for arrangement of various workstation outlets including jack types and quantities within each outlet type. All voice/data/video/audio and fiber jacks indicated in the faceplate shall be deemed included in this specification unless specifically noted otherwise.

6) Faceplates shall be stainless steel

2.4 STATION CABLE TERMINATION ASSIGNMENTS

A. Refer to the drawings for assignment of local A/V station cabling to the respective outlets and equipment.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Refer to drawings for quantity and arrangement of technology outlets including jacks and cabling.

B. Make all terminations at outlets and equipment and at each workstation outlet jack utilizing a tool appropriate for the equipment as recommended by the equipment manufacturer.

C. Coordinate color requirements for all jacks, station cables, patch cables, etc. with Owner / Engineer. Color coding shall be consistent for all like equipment.

D. Delivery of all loose equipment which is to be turned over to Owner shall be carefully coordinated and scheduled with Owner prior to shipment.

3.2 WIRING INSTALLATION

A. Interior - All station cables shall be run in conduit from outlet to above accessible ceiling extended from suspended cable management system out to local outlet or equipment as indicated on drawings and specifications. All cabling shall be run parallel or perpendicular to building lines.

B. The drawings do not indicate specific routes for telecommunications cables. The Telecommunications Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental cable management pathways and systems so that all structured cabling adhere to specific codes and standards specifically developed for the installation of such cables. Where the use of existing cable management systems and pathways would cause the structured cable system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc, the Telecommunications Contractor shall be responsible for developing alternative pathways and shall include all labor and material for doing so within the scope of this work.
C. In areas where there is not an installed raceway system (conduits or cable tray) and a cable support system is required, this contract shall be responsible for providing a Cable Management System. Cable management system shall provide support no more then 5’ on center. Where cables are installed open wired through the use of cable management systems, they shall be installed such that there is a minimum sag of 4 inches for every 4 foot of horizontal run. Cable pathways shall provide the following minimum clearances (parallel or perpendicular):

1) Motors and transformers – 48”.
2) Conduit and cable used for electrical power distribution – 12”.
3) Fluorescent lighting – 5”.
4) Power lines up to 2kVA – 5”.
5) Power lines over 5kVA – 24”.
6) Hot water/steam lines - Bare –18”, Insulated – 6”.

D. Cable management system shall be secured to building structure utilizing manufactured approved methods and hardware.

E. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building’s structure such as beams, joists, etc. to hang cable from will not be acceptable.

F. Cables shall be handled and installed with extreme care. Tie wraps shall loosely hold cables; do not overtighten. Cables shall have sweeping bends and shall have a maximum bending radius at any point in the installation of not less then 4 times the outer diameter of the cable. The cable manufacturer’s recommended bending radius and maximum pulling tensions shall be strictly adhered and shall not be exceeded. Failure to comply will result in the removal and replacement of affected cable at no additional cost to the Owner.

G. Provide adequate cable slack at each workstation outlet and the IDF/MDF termination equipment as follows:

1) Workstation outlet:
   a) 12” of slack.

H. Where cables are installed in conduit, the conduit system shall conform to the following:

1) No section of conduit shall be longer then 100 feet between pulling points.
2) No more then two 90 deg. Bends in a section of conduit between pulling points.
3) Each section of conduit shall be labeled for length, destination closet and origination closet.
4) Refer to EIA/TIA 569-A for specific conduit and pull box requirements.
I. All cabling installed in underground conduit installations shall be outdoor rated cables, acceptable for use by the manufacturer in underground applications.

3.3 IDENTIFICATION/LABELING

A. The Contractor shall be responsible for labeling all supplied communications equipment, cable, etc. in accordance with the guidelines as described herein. The end of each cable, each jack, patch panel, cross-connect and rack/backboard shall be identified and permanently recorded on 8.50 X 11 sheets attached to each rack/backboard.

B. Each cable and jack shall be labeled at every location where they are administered per TIA/EIA-606.

C. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.4 TESTING GENERAL

A. The Contractor shall be responsible for testing all installed Structured cables including:

1) Audio-Video

B. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted. All final test reports shall utilize the field installed labels at each outlet for the test of the corresponding outlet. Test reports which contain temporary generic or incorrect labels will not be accepted.

C. The Contractor shall be responsible for testing all installed audio-video station cables.

D. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted.

E. Tests shall be witnessed by Architect / Engineer / Owner and shall be monitored by a recorder.

F. System testing shall be performed with final test results turned over to the Owner prior to acceptance of the system. Missing or incomplete test results will not be reviewed and the system will not be commissioned by the Owner / Architect / Engineer.

G. Instruments and labor required for tests shall be furnished by the Contractor. All system test equipment shall be approved by the Owner / Architect / Engineer prior to application.

H. The Owner / Architect / Engineer reserve the right to spot test 5% of the installed cabling plant to verify documented test results. Where the Owner / Architect / Engineer have determined that the installed cable plant does not agree with the documented test results, the contractor shall be responsible for re-testing the installed voice/data/fiber cabling plant and revising/updating all test documentation as required.
I. Instruments required for tests shall be furnished by the Contractor.

3.5 TESTING A/V CABLEING

A. Upon completion of installation and satisfactory testing of system by Contractor in presence of the equipment supplier, the Contractor shall test the system in the presence of the Owner and the Engineer to demonstrate satisfactory performance.

B. System shall be tested by and a certificate of inspection shall be furnished by a qualified manufacturer’s representative or equipment vendor; Submit report indicating result to the Engineer.

3.6 SYSTEM ACCEPTANCE REQUIREMENTS

A. The contractor shall submit printed test results per the testing specification requirements for review by the Engineer/Owner prior to system acceptance. Any cable components that have not passed the full requirements of the system testing shall be replaced and re-tested at the contractor’s expense prior to system acceptance.

3.7 AS-BUILT DOCUMENTATION

A. Refer to Section 27 05 01 for submittal requirements.

B. Copies of all approved shop drawings with the Engineer’s stamp.

C. Technology drawings updated with final as-built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.

   1) AutoCAD architectural floor plans at a scale of 0.125”=1’-0” on 30x42 size sheets showing the location and label of each workstation outlet, IDF closet and MDF closet. Labeling shall match the labeling installed in the field. These drawings shall be as-built conditions.

   2) System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

D. Cable Test Results - Provide bound documents of all cable test results in printed format and in software version on a compact disc. Software version must include any required reader software where file formats are proprietary or non-standard text files. Cable test results shall be organized by media (fiber, copper) and by closet. Information must be included in O&M Manuals.

E. Create a detailed records sheet for the station cabling including floor plans showing outlet locations and which jacks are in which outlet. Records shall indicate connection rack/backboard, patch panel / cross-connect and jack / port, at both ends, for each cable. Provide with O&M Manual.
F. The entire structured cabling system as specified herein shall be guaranteed against defects in workmanship and materials as described herein. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

3.8 WARRANTY

A. The entire structured cabling system as specified herein shall be guaranteed against defects in workmanship and materials for a period of one (1) year. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. The Installing Contractor shall provide the initial warranty service. The extended warranty shall be provided by the manufacturer. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

END OF SECTION 271543
SECTION 272100 - DATA COMMUNICATIONS NETWORK EQUIPMENT

PART 1 - GENERAL

1.1 GENERAL

A. These specifications shall be utilized for the complete system as specified herein and as shown on the bid documents.

1.2 SCOPE OF WORK

A. Provide the manufacturer specified equipment as per this specification and the document drawings.

B. This Contractor shall be responsible for providing, installing and labeling all required fiber jumpers and copper patch cables to connect network electronics to the router.

C. Online UPS units to support network electronics as described herein and as shown on the contract documents.

D. Network management software licenses for all equipment installed under this project.

E. Programming of each switch and router to coordinate with the Owner’s LAN and WLAN Network Operating System configuration and requirements including establishing parameters and operations associated with QoS, CoS, VLANs, WLAN, etc.

1.3 SYSTEM DESCRIPTION

A. The network electronics shall provide full-duplex, auto-sensing 10/100/1000 BASETX UTP, ethernet ports for wired data jacks. The edge switches shall provide full layer 2 switching.

B. Power Over Ethernet

1. Where POE is required in the edge switches, the edge switches shall provide IEEE 802.3at compliant Class 1/2/3 PoE+ on all provided ports.

C. The network electronics shall provide full duplex gigabit uplink modules in each switch to connect to the main wiring closet router.

D. The network electronics shall provide software management capabilities such as Virtual LANs (VLANs), multilevel access security, and group management protocol. Software management shall be web-based and utilize a standard web browser. VLAN trunks shall be capable of being created from any port on any switch using IEEE 802.1Q standards based tagging. The main switch chassis shall provide full layer 3 switching and routing.

E. The network electronics shall provide features associated with Quality of Service (QoS) and Class of Service (CoS) as well as port-based prioritization. The QoS shall be based upon IEEE 802.1
1.4 QUALITY ASSURANCE

A. The Contractor shall maintain a fully equipped, factory certified service organization which under normal business operations will provide full maintenance and service of the installed system within 24 hours.

B. The equipment supplier shall have been an authorized distributor of the equipment provided for a minimum of 3 years. The equipment supplier shall provide factory trained technicians for programming, installation support and training of personnel. The equipment supplier shall be Cisco Certified for the VoIP solution.

C. All system components shall be UL listed.

D. Installation shall be in compliance with the National Electric Code and all other applicable codes.

E. The system shall be in compliance with all FCC Rules and Regulations.

F. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation. All switch components shall be of a single manufacturer.

1.5 CONTRACTOR QUALIFICATIONS

A. The Network Electronics System shall be furnished, installed and programmed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the contractor to utilize a sub-contractor for any portion of the work, unless the sub-contractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.

B. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.

C. The Contractor shall employ factory trained service personnel for the service and maintenance of the system.

D. The Contractor shall have had a minimum of 1 year experience with the specified Network Electronics. This experience shall include having completed a minimum of 2 installations in the past 12 months of similar size and scope. The Contractor shall provide references and contact information for the project sites in which the qualifying installations occurred.

1.6 SHOP DRAWINGS

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturer’s data sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.
1. Drawings shall include designations, dimensions, operating controls, electrical requirements, input/outlet configurations, operating controls, etc.
2. Major components including all sub-assembly components (daughter cards, option cards, etc.) required to perform the specified functions.
3. Any items of equipment which have features and/or functions that deviate from the specifications contained herein, shall have these deviations clearly called out by a separate attachment with the shop drawings specifically listing and detailing the deviation along with a justification. Deviations must be approved specifically in writing.

C. Job specific wiring diagrams.
1. This indicates a block diagram that shows all major items of equipment required for the contract project and the actual interconnection that will be installed.
2. Riser diagram showing conduit requirements with pull boxes, outlet boxes, part numbers of cable used, and a number of circuits in each conduit.
3. Electrical power requirements for the head-end and ancillary equipment. Include diagrams for any remote control of electrical power, in sufficient detail to coordinate with electrical work. Electrical diagrams shall also indicate all required plug and power outlet configurations including where direct connection is required/preferred.
4. Schematic and point-to-point wiring diagrams showing all devices and wiring.
5. Details of interconnection with other systems

D. Supplier shall provide rack elevations showing the configuration of all rack mounted equipment including detailed interconnection diagrams between equipment

E. 30x42 floor plans at a scale of not less than 1/8 inches=1 foot-0 inches showing the location of all items of equipment. Drawings shall also indicate each location where electrical power is required, and the specific configuration of that power connection (voltage, plug type, mounting height, etc.)

F. Software data – The data package shall consist of manufacturer fee data sheets of all system and application software being provided with sufficient information to verify that all specified features and functions are being addressed.

G. Proposed construction details for all custom fabricated items, including wall plates, interface panels, mounting hardware and systems, and rigging hardware. These details shall show labeling, dimensions and indicate finishes and color selection.

H. Operating License (if required) – Submit evidence of application for operating license prior to installation of equipment. Furnish the license, or if the license has not been received, a copy of the application for license, to the owner prior to operating the equipment. When license is received, deliver original license to owner.

I. Submittals that do not contain all the required information will be REJECTED unless prior approval for partial submittals has been approved.
PART 2 - PRODUCTS

2.1 PRODUCT EQUIVALENCY

A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor’s expense.

B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

2.2 NETWORK GEAR

A. Network Router (Cisco 2921)

<table>
<thead>
<tr>
<th>Item</th>
<th>Part Number</th>
<th>Qty</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CISCO2921/K9</td>
<td>1</td>
<td>Cisco 2921 with 3 onboard GE, 4EHWIC slots, 3 DSP slots, 1 ISM Slot</td>
</tr>
<tr>
<td>2</td>
<td>SL-29-DATA-K9</td>
<td>1</td>
<td>Data License for Cisco 2901-2951</td>
</tr>
<tr>
<td>3</td>
<td>SL-29-UC-K9</td>
<td>1</td>
<td>Unified Communications License for Cisco 2901-2951</td>
</tr>
<tr>
<td>4</td>
<td>SL-29-SEC-K9</td>
<td>1</td>
<td>Security License for Cisco 2901-2951</td>
</tr>
<tr>
<td>5</td>
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B. IDF Switches (Cisco 2960X)

<table>
<thead>
<tr>
<th>Item</th>
<th>Part Number</th>
<th>Qty</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>WS-C2960X-48FDP-L</td>
<td>4</td>
<td>Catalyst 2960-X 48 Gig-E, PoE, 2x10GBE SFP+, Lan Base</td>
</tr>
<tr>
<td>2</td>
<td>C2960X-STACK</td>
<td>4</td>
<td>Catalyst 2960-X Flex Stack Plus Stacking Module</td>
</tr>
<tr>
<td>3</td>
<td>CAB-C15-CBN</td>
<td>4</td>
<td>Cabinet Jumper Power Cord, 250VAC, 13A, C14-C15 Connectors</td>
</tr>
<tr>
<td>4</td>
<td>CAB-STK-E-1M</td>
<td>4</td>
<td>Cisco FlexStack 1m Stacking Cable</td>
</tr>
<tr>
<td>5</td>
<td>CON-SNTP-WSC296XL</td>
<td>4</td>
<td>Smartnet 8x5xNDB Catalyst 2960-X, 48GigE, PoE, 740W 2x10</td>
</tr>
</tbody>
</table>

2.3 UPS Units - Provide line interactive, battery back-up, power conditioning UPS, rack mounted in each TR to serve network electronics as indicated on the drawings. Unit shall utilize combination of battery and microprocessor regulation to provide protection from brownouts and over voltage. UPS to have the following features at a minimum:

A. 3000VA capacity as indicated on drawings

B. Output Operating Range – 120V nominal
C. Communications – Unit shall provide an Ethernet based SNMP management interface, through the LAN to provide remote diagnostics and alarm conditions. Provide vendor management software with all applicable licenses.

D. Expandability – Unit shall provide for the connection of external battery packs in modules to extend the total unit run-time.

E. 3000 VA – minimum of four (4) NEMA 5-15R and two (2) NEMA 5 –20R receptacles switched and conditioned. 12 feet line cord with 120V 30A twistlock plug. Final plug configurations shall be coordinated with equipment served. Any accessories or customization of Uninterruptable Power Supply unit shall be the responsibility of the contractor prior to ordering.

F. Rack mounted.

G. Unit as manufactured by APC, Liebert, Chloride, or Tripp Lite, Minute Man.

H. Refer to drawings for sizes, quantities and configuration.

2.4 PATCH CABLES

A. This Contractor shall be responsible for providing all required fiber and copper patch cables at each switch uplink port and main core switch uplink ports to make a complete and fully functioning network. The following patch cables requirements are considered part of these specifications:

1. Copper patch cable – provide patch cables at each edge switch requiring copper uplink ports and copper patch cables at each copper 1000BASE TX port in the chassis switch to fully connect the network. Patch cables to match the EIA/TIA channel configuration of the cabling system. Coordinate patch cable length and color to provide a neat, orderly and workman like appearance after system patching is complete.

B. This Contractor shall be responsible for coordinating with the 27 15 13 contractor regarding patch cables being supplied by the 27 15 13 Contractor for patch panel-to-switch patching. Final quantities and lengths of patch cables shall be arranged to provide the cleanest best managed patching solution. This Contractor is responsible for taking delivery of the patch cables, installing the patch cables and labeling each end for patch panel port and switch port identification.

PART 3 - INSTALLATION

3.1 GENERAL INSTALLATION

A. Install systems in accordance with UL, NEC and all other applicable codes. Install system to comply with drawings and final shop drawings in compliance with manufacturer instructions. Provide all required hardware and labor for rack mounting of system components.

B. Some network electronics such as layer 2 switches, UPS units, etc., will be required to be mounted in relay racks and server cabinets provided under Section 27 11 00. Careful coordination with 27 11 00 contract will be required. This coordination shall include providing all required dimensional, weight and mounting data to the 27 11 00 Contractor to ensure a fully coordinated installation.
C. It is the Contractor’s responsibility to program the devices in this section according to the Owner’s Network requirements. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming.

D. Provide any miscellaneous equipment such as identification tags, cable tie, wiring harnesses, patch cables (both copper and fiber), stacking cables etc. necessary for a complete TURNKEY system.

E. Provide all required jumper and patch cables and coordination with the Owner to connect to the Owner’s File Server(s).

F. Install and setup all UPS equipment. Review power down procedure with the Owner.

3.2 GROUNDING

A. The installing contractor shall be responsible for ensuring the grounding integrity of all installed equipment to eliminate the potential for equipment or personnel hazards due to improperly or inadequately grounded systems.

B. All grounding and bonding shall be in conformance with the National Electric Code, article 250 and as recommended by EIA/TIA-607.

C. The Division 26 Contractor has provided 120V branch circuitry for use by the contractor. The branch circuitry is run with a dedicated equipment grounding conductor which shall be utilized by the system equipment. In no case shall the installation compromise the integrity of the Building Electrical Grounding System.

3.3 TELECOMMUNICATIONS ROOMS

A. The lay-out of the telecommunications rooms as depicted on the drawings shall be utilized as a general guide for bidding purposes. The final room layout shall be carefully coordinated with input from the Owner and from other trades with equipment and/or cabinets to be placed in the room. Final configuration of telecom rooms shall be submitted to Engineer as a coordination drawing with information from all other trades occupying the same room for review prior to permanent mounting of equipment or termination of cabling.

B. Coordinate lay-out of telecom rooms to avoid placing telecommunications equipment and cabinets under water piping (other than sprinkler heads) or HVAC units.

C. Coordinate lay-out of telecom rooms with electrical plans and locations of electrical outlets.

D. Lay-out of telecommunications equipment cabinets and racks shall provide a minimum of 36inches isle in front and behind equipment racks and cabinets which is clear of obstructions or equipment protrusions.

E. Coordinate rack locations and orientation to maintain required clearances including any equipment depths that may have to be accounted for. Some equipment, such as UPS units may have special mounting requirements that need additional coordination.
3.4 PROGRAMMING

A. It is the Contractor’s responsibility to program the system in this section according to the Owner’s wishes. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming. This programming agreement shall then be written out in detail and forwarded to the Engineer for approval. After approval is granted, proceed with final programming.

B. Network Electronics shall provide seamless communications between IBM PC based workstations and Macintosh workstations running TCP/IP protocol. Switches shall be able to accept, route and process ethernet traffic from either platform.

3.5 IDENTIFICATION/LABELING

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.

B. The contractor shall be responsible for applying a permanent label to each fiber/copper patch cable to indicate source and destination. This label shall indicate patch panel and port at switch side and switch and port at patch panel side. Fiber jumpers utilized to serve uplinks to remote switches shall be labeled with closet and switch on chassis side and fiber port in chassis on switch side.

C. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

D. Provide a printed, computer generated record of each connected port in each switch. Label shall indicate data jack label, port and switch label and closet label.

3.6 TESTING

A. The Contractor shall be responsible for energizing and testing each port. This test shall include “rack-to-jack” and from main switch to switch “stacks”. The contractor shall be responsible for ensuring that the network is in proper working condition.

B. The Contractor shall be responsible for testing and verifying that all software and management level functions of the system as required by the Owner’s Network system are programmed and operating properly. This includes but is not limited to:

1. Set-up and segregation of VLANs as required by the Owner on a per port and per switch basis.
2. Switch clustering and addressing through a single IP address.
3. Operation of remote monitoring events such as alarm, history, statistics, events, etc.
4. Set-up of multi-level security including MAC addressed-based and terminal access control to prevent unauthorized users from altering the configurations.
5. Setup and administration of prioritization, quality of service, IP clustering, video multi-casting, voice over IP, etc.
3.7 TRAINING

A. Provide the Owner with a minimum of 4 hours of training designed to make all users familiar with the operation of the system.

B. Provide all training and utilize specified manuals and record documentation. All training shall be provided at the project site and coordinated with the Owner.

C. Training shall include multiple four-hour sessions encompassing all instructions required for system operation. Provide operators manuals and user guides with training. Provide follow up training after initial training.

D. Training shall utilize the equipment provided at the project site. Coordinate use, time and availability of equipment with the Owner.

E. Demonstrate adjustment, operation and maintenance of the system including each component and control.

3.8 AS-BUILT DOCUMENTATION

A. The Contractor shall furnish the Owner complete electronic as-built manuals in an 8.5 inches x 11 inches format. Drawings shall be a minimum of 11 inches x 17 inches engineering format. These manual shall be assembled in a loose leaf binder and shall contain:

1. System Schematic Diagram(s)
2. As-Built Drawings of Entire System including Equipment Rack Elevations
3. Component Technical Operating Manuals
4. Port and Switch Labeling
5. Final Endurance Test Report

B. Maintenance Manual: The maintenance manual shall describe maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

C. The contractor shall provide a new district network map indicating all new buildings included in this scope of work. Network map shall include equipment info, IP addresses, VLAN information, etc. Network map shall be prepared utilizing a computer drafting program such as AutoCAD or Visio, and shall be presented in printed and electronic format.

3.9 WARRANTY

A. Warrant all workmanship, equipment, material and software entering into this contract for a period of three (3) years from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Provide a statement of this warranty with the O & M manuals.

B. During the warranted operation, the Contractor shall perform two inspections at 6-month intervals or less. This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays. Resolve any previous outstanding problems.
C. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

D. The Contractor shall be responsible to provide service during normal working hours on a normal business day within (4) hours after notification by the Owner for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of 25 percent or more of system components operation, or the loss of the main switch or other head-end equipment which renders the entire system beyond 50 percent inactive or unusable. Provide an on-site authorized factory technician within 24 hours if required.

E. If equipment cannot be repaired within 24 hours of service visit, Contractor shall provide “loaner” equipment to the Owner at no charge.

3.10 CERTIFICATION

A. Upon completion of the testing, the manufacturer or representative shall issue to the Owner a letter of certification attesting to the fact that he has tested and adjusted the system, that all components are properly installed and free of defects, and that the system is in compliance with this specification.

PART 4 - UNIT PRICES

4.1 UNIT PRICE SCHEDULE

A. The Contractor shall provide a unit price for the following items listed in this document:

1. 48 port POE edge switch with two (2) GBIC uplink ports module.
2. Rack mounted UPS – 3000VA

END OF SECTION
SECTION 272133 - DATA COMMUNICATIONS WIRELESS ACCESS POINTS

PART 1 - GENERAL

1.1 GENERAL

A. These specifications shall be utilized for the expansion of the existing Meraki WLAN as specified herein and as shown on the bid documents.

1.2 SCOPE OF WORK

A. This specification section is intended to provide a complete installation of the Wireless Local Area Network Electronics (WLAN) system as indicated herein and as shown on the contract documents.

B. Install owner furnished wireless access points (AP). Provide and install mounting hardware, cabling, RF Site Survey, programming, and testing as required to provide a complete and comprehensive WLAN within the specified areas.

C. Programming of each AP to coordinate with the Owner’s LAN Network Operating System and mobile wireless client device configuration and requirements including establishing parameters and operations associated with security, QoS, CoS, VLANs, etc.

1.3 QUALITY ASSURANCE

A. The Contractor shall maintain a fully equipped, factory certified service organization which under normal business operations will provide full maintenance and service of the installed system within 24 hours.

B. The equipment supplier shall have been an authorized distributor of the equipment provided for a minimum of 3 years. The equipment supplier shall provide factory trained technicians for programming, installation support and training of personnel.

C. All system components shall be UL listed and shall comply with all applicable FCC regulations regarding operation and installation.

D. Installation shall be in compliance with the National Electric Code and all other applicable codes.

E. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation. All switch components shall be of a single manufacturer.

1.4 CONTRACTOR QUALIFICATIONS

A. The Network Electronics System shall be furnished, installed and programmed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the contractor to utilize a sub-contractor for any portion of the work, unless the Subcontractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.
B. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.

C. The Contractor shall employ factory trained service personnel for the service and maintenance of the system.

D. The Contractor shall have had a minimum of 1 year experience with the specified Network Electronics. This experience shall include having completed a minimum of 2 installations in the past 12 months of similar size and scope. The Contractor shall provide references and contact information for the project sites in which the qualifying installations occurred.

1.5 SHOP DRAWINGS

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

   1. Drawings shall include designations, dimensions, operating controls, electrical requirements, input/outlet configurations, operating controls, etc.
   2. Major components including all sub-assembly components (daughter cards, option cards, etc.) required to perform the specified functions.
   3. Any items of equipment which have features and/or functions that deviate from the specifications contained herein, shall have these deviations clearly called out by a separate attachment with the shop drawings specifically listing and detailing the deviation along with a justification. Deviations must be approved specifically in writing.

C. 30x42 floor plans at a scale of not less than 1/8 inch=1 foot-0 inches showing the location of all items of equipment. Drawings shall also indicate each location where electrical power is required, and the specific configuration of that power connection (voltage, plug type, mounting height, etc.)

D. Software data – The data package shall consist of manufacturer’s data sheets of all system and application software being provided with sufficient information to verify that all specified features and functions are being addressed.

E. Proposed construction details for all custom fabricated items, including wall plates, interface panels, mounting hardware and systems, and rigging hardware. These details shall show labeling, dimensions and indicate finishes and color selection.

PART 2 - PRODUCTS

2.1 PRODUCT EQUIVALENCY

A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor’s expense.
B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

C. The Meraki cloud based solution will be bid with a complete five year program

2.2 Access Points  (Access points are being furnished by the Owner and installed by the contractor)

A. Manufacturer: Meraki MR26

2.3 SPARE AP

A. The contractor shall include with the bid, 10 percent but no less than two (2) additional cable drops for APs that will be applied as needed during the site survey to correct for RF coverage issues. The contractor shall include 250 feet of data cable along with termination and testing installation of the AP for a fully installed and operational AP.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Install systems in accordance with UL, NEC and all other applicable codes. Install system to comply with drawings and final shop drawings in compliance with manufacturer instructions. Provide all required hardware and labor for rack mounting of system components.

B. Prior to installation of cabling for access points, the contractor shall perform an on-site validation survey. This survey shall be utilized to obtain actual site conditions including RF environment and RF properties of the construction. The validation survey shall be used by the contractor to fine tune the AP design/lay-out, and set the final quantities and locations of access points. The site validation survey shall be conducted to meet the following minimum requirements:

1. Utilize the appropriate RF sensing equipment to locate, identify and document any sources of RF activity within the area that could degrade or interfere with the WLAN.
2. Evaluate construction and possible obstacles to RF operation to determine final location of all APs and proper selection of antenna types.
3. Evaluate potential for RF signal leakage outside the building and adjust AP locations, power settings and antennas types to minimize leakage. The exception is specific areas of the site specifically requested to have WLAN coverage.

C. After the system is installed, the contractor shall perform a Network Validation Survey. This survey shall test the actual RF environment with the access points operating and the WLAN system functioning including all APPS designed to operate via the WLAN. The network validation will test, document and provide certification that the various operating parameters of the WLAN are being met to a degree required by the various APPS running over the WLAN. The network validation survey shall be conducted to meet the following minimum requirements.

1. Finalize channel and power settings of each AP based upon location, proximity to adjacent APs, desired data throughput, desired exterior WLAN coverage and possible sources of RF interference.
2. Review antenna selection and make adjustments to individual APs as required.
3. Verify that the system can meet or exceed the minimum recommendation of 20-25dB SIR for VoWiFi applications.

D. It is the Contractor’s responsibility to program the devices in this section according to the Owner’s Network requirements. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming.

E. Provide any miscellaneous equipment such as identification tags, cable tie, wiring harnesses, patch cables (both copper and fiber), stacking cables etc. necessary for a complete TURNKEY system.

F. Provide all required jumper and patch cables and coordination with the Owner to connect to the wired LAN.

G. Install and setup all UPS equipment. Review power down procedure with the Owner.

3.2 GROUNDING

A. The installing contractor shall be responsible for ensuring the grounding integrity of all installed equipment to eliminate the potential for equipment or personnel hazards due to improperly or inadequately grounded systems.

B. All grounding and bonding shall be in conformance with the National Electric Code, article 250 and as recommended by EIA/TIA-607.

C. The Division 26 Contractor has provided 120V branch circuitry for use by the contractor. The branch circuitry is run with a dedicated equipment grounding conductor which shall be utilized by the system equipment. In no case shall the installation compromise the integrity of the Building Electrical Grounding System.

3.3 PROGRAMMING

A. It is the Contractor’s responsibility to program the system in this section according to the Owner’s wishes. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming. This programming agreement shall then be written out in detail and forwarded to the Engineer for approval. After approval is granted, proceed with final programming.

B. Develop a minimum of three levels of wireless access. The groups shall include “Guest”, “Staff”, and “Student”. Coordinate access privileges, Vlon, Sub-Net Assignments, Resource Allocation, etc. for each group.

3.4 IDENTIFICATION/LABELING

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.

B. All labeling and recording shall be approved by the Owner and the Engineer prior to application.
C. Provide a printed, computer generated record of each connected port in each switch. Label shall indicate AP served, port and switch label and closet label.

3.5 TESTING

A. The Contractor shall be responsible for energizing and testing Access Point. The contractor shall be responsible for ensuring that the WLAN is in proper working condition.

B. The Contractor shall perform a minimum series of on-site RF survey with network verification and include the results in the O & M manuals:

1. Visual Inspection – Note condition of interior spaces along with potential barriers/obstacles to RF transmission that may not be shown on the architectural floor plans.
2. RF Spectrum Test – The Contractor shall walk the site and record the general RF environment that currently exists throughout the building. Special attention shall be paid to RF signals in the 802.11 band.
3. Ping Test – The Contractor shall walk the site recording a continuous network ping test to validate that there are no significant quantities or response time out events. Areas which result in a high number of time-out requests (more than 5 percent) consistently long ping times (more than 5ms) shall be flagged for further evaluation in the RF survey and AP configuration.
4. Packet Analyzer – The final AP configuration showing channel utilization, SSIDs, device MAC addresses and associated compiled signal strength measurements of a site walk.

C. The Contractor shall be responsible for testing and verifying that all software and management level functions of the system as required by the Owner’s Network system are programmed and operating properly. This includes but is not limited to:

1. Set-up and segregation of user groups, VLANs, security and authentication as required by the Owner.
2. Set-up of multi-level security including authentication and encryption.
3. Set-up and administration of prioritization, quality of service, voice-over-IP, etc.

3.6 TRAINING

A. Provide the Owner with a minimum of 60 hours of training designed to make all users familiar with the operation of the system.

B. Training shall be broken down in the following topics

1. Installation and operation of AP
2. Installation and operation of the WLAN Controller
3. Installation and operation of the Wireless Control System

C. Provide all training and utilize specified manuals and record documentation. All training shall be provided at the project site and coordinated with the Owner.

D. Training shall include multiple four-hour sessions encompassing all instructions required for system operation. Provide operators manuals and user guides with training. Provide follow up training after initial training.
E. Training shall utilize the equipment provided at the project site. Coordinate use, time and availability of equipment with the Owner.

F. Demonstrate adjustment, operation and maintenance of the system including each component and control.

G. Provide all training and utilize specified manuals and record documentation. Training shall be provided to all staff at the project site and coordinated with the Owner. Provide two (2) video copies of training.

3.7 AS-BUILT DOCUMENTATION

A. The Contractor shall furnish the Owner two (2) complete bound as-built manuals in an 8.5 inch x 11 inch format. Drawings shall be a minimum of 11 inches x 17 inches engineering format. These manual shall be assembled in a loose leaf binder and shall contain:

1. System Operating Instructions
2. System Functional Block Diagram(s)
3. System Schematic Diagram(s)
4. System Wiring Diagrams
5. As-Built Drawings of Entire System including Equipment Rack Elevations
6. Component Technical Operating Manuals
7. Component Service Manuals
8. Software Operating Manuals
9. Final Endurance Test Report

B. Maintenance Manual: The maintenance manual shall describe maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

3.8 WARRANTY

A. Warrant all workmanship, equipment, material and software entering into this contract for a period of three (3) years from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Provide a statement of this warranty with the O & M Manuals.

B. During the warranted operation, the Contractor shall perform two inspections at 6-month intervals or less. This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays. Resolve any previous outstanding problems.

C. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

D. The Contractor shall be responsible to provide service during normal working hours on a normal business day within (4) hours after notification by the Owner for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of 25 percent or more of system components operation, or the loss of the main switch or other head-end equipment which renders the entire system beyond 50 percent inactive or un-useable. Provide an on-site authorized factory technician within 24 hours if required.
E. If equipment cannot be repaired within 24 hours of service visit, Contractor shall provide “loaner” equipment to the Owner at no charge.

3.9 CERTIFICATION

A. Upon completion of the testing, the manufacturer or representative shall issue to the Owner a letter of certification attesting to the fact that he has tested and adjusted the system, that all components are properly installed and free of defects, and that the system is in compliance with this specification.

END OF SECTION 272133
SECTION 273123 - INTEGRATED TELEPHONE SYSTEM – IP TELEPHONY

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Expansion of the existing Cisco Internet Protocol (IP) based telephony solution providing a converged voice/data/video network with:

1. SRST and PSTN interface on new building routers.

1.2 SYSTEM DESCRIPTION

A. The existing Cisco implementation is version 8.6.2. for the Call Manager and Unity. Scope of work requires any software and licensing additions to provide the SRST at this branch included with this project for the new building routers.

B. PSTN Interface – Provide equipment to serve as gateways to the PSTN and interface with analog CO trunks, ISDN PRI circuits, DS1 circuits, caller ID, and E911 services.

C. Each Building - Provide Power Failure Transfer (PFT) unit for E-911 and emergency backup including one (1) analog PFT emergency backup phone.

1.3 QUALITY ASSURANCE

A. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.

B. All system components shall be UL listed.

C. Installation shall be in compliance with the National Electric Code and all other applicable Codes.

D. The system shall be in compliance with all FCC rules and regulations.

E. The Contractor shall employ factory trained and certified service personnel for the installation, service and maintenance of the system.

1.4 CONTRACTOR QUALIFICATIONS

A. The IP Telephony System shall be furnished, installed and programmed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the IP Telephony System contractor to utilize a sub-contractor for any portion of the work, unless the sub-contractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.

B. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.
C. The Contractor shall employ factory trained service personnel for the service and maintenance of the system.

D. The Contractor shall have had a minimum of 1 year experience with the specified IP Telephony System. This experience shall include having completed a minimum of 2 installations in the past 12 months of similar size and scope. The Contractor shall provide references and contact information for the project sites in which the qualifying installations occurred.

1.5 SHOP DRAWINGS

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

C. Qualifications

1. A statement of contractor’s qualifications to verify compliance with other provisions within the specifications, unless the contractor has been pre-approved.

1.6 All materials furnished under this contract shall be new, of highest quality, and shall be of a regularly manufactured line, currently in production at the time of installation.

PART 2 - PRODUCTS

2.1 PRODUCT EQUIVALENCY

A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor’s expense.

B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

2.2 GENERAL

A. This is an expansion of an existing Cisco IP Telephony solution.

2.3 PSTN GATEWAY

A. Provide for analog and digital services gateway to the PSTN including:

1. 4 analog CO trunks with capabilities to support up to 16 CO trunks
2. Integrated CSU/DSU for ISDN PRI interface

B. Gateway shall provide the additional features and capabilities:
1. 4 analog station ports with support for a maximum of 8
2. Dual Ethernet 10/100 switch ports for connection to the Local Area Network (LAN).

C. The gateway shall be able to act as a back-up call processing agent for a limited number of phones in the event of a failure of the primary call processing agent.

D. The gateway shall be capable of routing calls through the PSTN as a backup means to utilizing the LAN for voice traffic.

E. Provide a minimum of one (1) CO port with power failure transfer relay to connect to analog phone.

2.4 CALL PROCESSING AGENT - EXISTING

2.5 VOICE MESSAGING SYSTEM – EXISTING

2.6 LIGHTNING PROTECTION

A. Provide a UL listed combination primary/secondary protector between the Teleco demarc primary protector and the telephone switch CO port connections. Protector shall provide solid state surge protection and PTC self-resetting sneak current protection. Coordinate proper surge voltage rating for incoming lines with telephone company prior to application.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. FCC registration number and certificate shall be provided.

B. Install systems in accordance with NEC 760 and other applicable codes. Install system to comply with drawings and final shop drawings in compliance with manufacturer instructions. Provide all required hardware and labor for rack mounting of head-end system components.

C. It is the Contractor’s responsibility to program the devices in this section according to the Owner’s wishes. This involves day and night restrictions for each phone station, time schedules, building zoning, etc. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming. This programming agreement shall then be written out in detail and forwarded to the Engineer for approval. After approval is granted, proceed with final programming.

D. The final extension and station numbering shall be identical to the room numbering system the Owner uses and displays throughout the building. Extensions within the building shall be reached by use of the room number from any handset.

3.2 GROUNDING

A. Contractor shall provide equipment-grounding connections for telephone systems as indicated or as directed by system supplier. Tighten connections to comply with tightening torque’s specified in UL Standard 486A to ensure permanent and effective grounds.
B. All consoles shall be provided with a #8 AWG ground wire to earth ground. Conduit shall not be acceptable for this purpose.

3.3 PROGRAMMING

A. It is the Contractor’s responsibility to program the system in this section according to the Owner’s wishes. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming. This programming agreement shall then be written out in detail and forwarded to the Engineer for approval. After approval is granted, proceed with final programming.

3.4 IDENTIFICATION/LABELING

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.

B. The contractor shall be responsible for generating and programming the labeling for camera information within the recorder software.

C. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.5 TELEPHONE SERVICE

A. Provide all labor and material required to make all final connections to the telephone service provider(s) Demarcation location and equipment. Coordinate with Owner selected telephone service provider(s).

3.6 TRAINING

A. Provide all training and utilize specified manuals and record documentation. Training shall be provided to all staff at the project site and coordinated with the Owner.

B. Training shall include all instructions required for system operation. Provide operators manuals and user guides with training. Provide a total of eight (8) hours of system training to the Owner.

C. Training shall utilize the equipment provided at the project site. Coordinate use, time and availability of equipment with the Owner.

D. Demonstrate adjustment, operation and maintenance of the system including each component and control.

3.7 PROJECT RECORD DOCUMENTS:

A. Copies of all approved shop drawings with the Engineer’s stamp.

B. Owner’s manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as
well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner’s manuals. CDs containing electronic versions of Owner’s manuals must contain the proper software viewers for each document type.

C. Technology drawings updated with final as-built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions. Drawings shall be coordinated and referenced to the O & M manuals and related wiring diagrams. Floor plan drawings shall be 0.125 inch = 1 foot AutoCAD drawings to provide for clear, legible documents. Provide the Owner a CD-Rom containing all final AutoCAD drawing files of the entire system and floor plans.

D. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

E. Provide statement of warranty with the O&M manuals.

3.8 WARRANTY

A. Warrant all workmanship, equipment, material and software entering into this contract for a period of three (3) years from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Provide a statement of this warranty with the O & M Manuals.

B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

C. The Contractor shall be responsible to provide service during normal working hours within (8) hours after notification by the Owner for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of 25 percent or more of outside line capacity, the loss of 25 percent or more of telephone stations, or the loss of the main console.

D. If equipment cannot be repaired within 24 hours of service visit. Contractor shall provide “loaner” equipment to the Owner at no charge.

END OF SECTION 273123
SECTION 274116 - INTEGRATED A/V SYSTEMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Work consists of the provision of new A/V equipment including local audio/video systems with source origination, distribution and control components.

B. Included in the Scope of this Section:

1) Licenses, permits as may be applicable
2) Provision of submittal information
3) Installation in accordance with contract documents, manufacturers’ recommendations and applicable codes
4) Programming and configuration of control and signal processing software
5) Testing and adjustments, including documentation thereof
6) Provision of manuals
7) Maintenance and warranty services

C. Applicable References:

1) National Electric Code (NEC)
2) Underwriters Laboratories (UL)
3) Sound System Engineering (Davis & Patronis) – 3rd Edition 2006
4) Audio Systems Design and Installation (Giddings) 1990
6) Telecommunications Distribution Methods Manual (TDMM)

1.2 DESCRIPTION OF WORK

A. The work consists of the installation of cabling and support infrastructure only for an AV signal distribution, display and control systems in the building as indicated on the plans and as specified herein. These areas and associated systems are as follows Refer to drawings for specific quantities and arrangements of systems within each space):

1) Meeting Room and Small Meeting Room
   a) Video Display Equipment (refer to section 274119)
      (1) Cabling and support infrastructure for an electric, wall mounted, projection screen.
      (2) Cabling and support infrastructure for a Ceiling Mounted Projector
   b) Cabling and support infrastructure for Digital video distribution with scaling.
   c) Audio
      (1) Cabling and support infrastructure for Ceiling speakers.
      (2) Cabling and support infrastructure for wireless microphone
      (3) Cabling and support infrastructure for Assistive Listening System
   d) Switching
(1) Cabling and support infrastructure for a Digital video Matrix Switcher

e) Sources
(1) Digital Video Input Jack plate.
(2) Blu-ray player

f) Control
(1) Cabling and support infrastructure for AV control & signal routing system.
(2) Cabling and support infrastructure for Wired AV System color touch panel controller.

g) Cabling
(1) All AV systems cabling including distribution, control and low voltage power.
(2) All required patch/equipment cords to make connection from AV outlets and AV system equipment

h) Wall mounted AV equipment rack with power distribution located in the adjacent storage room.

2) Technology Room
a) Similar functionality to Meeting Rooms with the following exceptions:
(1) Wireless microphone, Assistive Listening System and Blu-ray player not required.
(2) Wall mounted equipment rack not required, electronics reside in ceiling mounted projector box.
(3) Push button wall controller in lieu of touch screen.

B. Control Software:

1) The Contractor shall provide complete programming of the integrated audio/visual system as closely coordinated with Dayton Library under the Contract. Coordination between the Contractor and The Dayton Library shall consist of, but not limited to that specified herein. The Contractor is responsible for modifications that may be necessary as a result of component substitutions. The modified code and all rights of ownership thereto shall be surrendered to The Dayton Library upon completion of the project.

a) Contractor shall attend a minimum of three (3) meetings with The Dayton Library to review programming and Control Flow specific to the project. The Contractor programmer shall attend these meetings.

b) Control Flow drawings shall be submitted in the format agreed during Meeting 1. Subsequent meetings will review the Control Flow diagram with all in agreement prior to implementation.

c) Technical review – Touch panel system mock-up meeting with The Dayton Library and the programmer.

d) End-user review – Touch panel system mock-up meeting with The Dayton Library and the programmer.

1.3 QUALITY ASSURANCE

A. Performance Verification: All digital video systems shall be pre-tested to verify the complete compatibility of all sending, receiving and distribution components and the performance and integrity of the transmission media. The performance of each system shall be demonstrated, with all proposed components, in the presence of the Design Engineer and/or Owner prior to approval and installation. Any system failing to meet the
specified performance requirements shall be rejected and re-configured as required prior to re-testing.

B. Installation shall be in compliance with the National Electric Code and all other applicable codes.

C. All equipment described herein or otherwise required to perform the specified system functions shall be a regular product line, produced by the system manufacturer.

D. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.

1.4 CONTRACTOR QUALIFICATIONS

A. The A/V equipment package shall be furnished and installed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the A/V contractor to utilize a sub-contractor for any portion of the work, unless the Subcontractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.

B. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.

C. Equipment supplier shall have a service organization within 75 miles of the project site.

D. The Contractor shall have on staff an Infocomm International-certified CTS-I AV systems engineer/project manager responsible for overseeing the project and the lead technician (not installers) shall have a CTS certification or an equivalent C-EST or NICET systems installer certification.

E. The Contractor shall have a Certified Programmer for the AV system being provided on staff. The Contractor shall provide a copy of the certificate bearing the name of the programmer. If the Contractor does not have a "Certified Programmer" on staff, that Integrator shall contract an independent programmer and provide, with the sealed bid, the name of the CAIP.

1) If using an independent programmer, the System Contractor will be legally bound to complete the integration with acknowledged IP. If something happens that requires a change in the use of said IP programmer, the Owner and Engineer must be notified, in writing, about the reason for the change and an alternative must be submitted for approval by the Owner and Engineer.

2) Documentation of the Integrator’s Certified Programmer’s continuing education shall also be submitted. Certified Programmer shall have completed continuing education training within the past 12 months of bidding on this RFP.

F. The Contractor shall be Certified for the digital video system and be able to demonstrate a minimum of one (1) installation of similar size and scope within the past year.

1.5 SHOP DRAWINGS
A. A complete list of materials with quantities, model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

C. Qualifications - A statement of contractor’s qualifications to verify compliance with other provisions within the specifications, unless the contractor has been pre-approved.

D. Job specific wiring diagrams.
   1) This indicates a system diagram that shows all major items of equipment required for the contract project and the actual interconnection that will be installed.
   2) System diagram shall have the level of detail required to install the system, not just general signal flow. Diagram to include but not limited to; cable types and connector pin-outs, all device connectivity including connections with other devices / ancillary systems, etc.

E. Supplier shall provide rack elevations showing the configuration of all rack mounted equipment including detailed interconnection diagrams between equipment.

F. 30x42 floor plans at a scale of not less than 1/8”=1’-0” showing the location of all items of equipment. Drawings shall also indicate each location where electrical power is required, and the specific configuration of that power connection (voltage, plug type, mounting height, etc.)

G. Software data – The data package shall consist of manufacturer’s data sheets of all system and application software being provided with sufficient information to verify that all specified features and functions are being addressed.

H. Submittals that do not include all the required documentation will be REJECTED.

PART 2 - PRODUCTS

2.1 PRODUCT EQUIVALENCY

A. Where products are listed with a single manufacturer only, the product listing is included to generate the basis of design. Contractors may submit alternative equipment and manufacturers to the Engineer for review and approval.
   1) Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions that the basis of design equipment includes. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

B. Where products are listed with multiple manufacturers, these manufacturers will be automatically approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor’s expense.
1) Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

2.2 Basis of design is the Extron DTP CrossPoint 82 4K IPCP MA 70 Presentation Matrix Switcher with integrated Matrix AV Switcher, Audio DSP (including feedback suppressor), Audio amplifier, Video Scaler and Control Processor. Standalone separate components can be substituted as long as the units meet or exceed the requirements of the Basis of design unit.

2.3 Audio Processing/Distribution – Meeting Rooms

A. Audio DSP - Equipment to provide Audio Matrix switching and DSP functionality.
   1) Matrix Switch - Minimum 6-in (balanced wide band mic/line) x 2-out (Stereo balanced).
   2) DSP – Available system components shall include (but not be limited to) various forms of: mixers, equalizers, filters, crossovers, dynamics/gain controls, routers, delays, remote controls, meters, generators, feedback suppression and diagnostics.
   3) Control – Ethernet, RS-232
   4) Basis of design is Extron DTP CrossPoint 82 4K IPCP MA 70 or equal by Crestron or AMX.

2.4 AUDIO AMPLIFIER

A. Meeting Rooms (minimum requirements)
   1) 100 watts (rms) @ 70 V, 1 kHz, 0.1% THD
   2) 80 Hz to 20 kHz, =1/-3 dB @ 1 watt
   3) High pass filter: 80 Hz, 12 dB/octave
   4) Basis of design is Extron DTP CrossPoint 82 4K IPCP MA 70 or equal by Crestron or AMX.

B. Technology Room
   1) Provide a single channel mono audio amplifier, to be located in the ceiling box to drive speakers for local AV system.
   2) Performance – 40 watts at 70 volts. Individual bass, treble and input levels, control for volume and connectivity to AV system remote volume control, Automatic clip limiter, auto power-down, balanced and unbalanced inputs, 1 RU - ¼ rack width in size.
   3) Extron MPA 401 or engineer approved equal.

C. Opportunity Room
   1) Provide a single channel mono audio amplifier, to be located in the ceiling box to drive speakers for local AV system.
   2) Performance – 60 watts at 70 volts. Individual bass, treble and input levels, control for volume and connectivity to AV system remote volume control, Automatic clip limiter, auto power-down, balanced and unbalanced inputs, 1 RU - ¼ rack width in size.
3) Extron MPA 601 or engineer approved equal

2.5 SPEAKERS

A. Meeting Room (circle “SR” subscript “A”)

1) Provide pendant mounted ceiling speakers for sound reinforcement for local AV system as detailed on the drawings.
2) Speakers shall be a two-way, full-range ceiling mount system with a 6.5” low frequency transducer with a coaxially mounted 1.0” high frequency transducer.
3) Performance – 80 Hz - 20 KHz Frequency response, 92 dB SPL sensitivity, tap settings of 7.5, 15, 30, and 60 watts and 8 ohms, 115 degree conical coverage (1 – 6 kHz).
4) Coordinate color of speakers with architect prior to ordering.
5) Community DP6 or engineer approved equal.

B. Small Meeting Room & Technology Room (circle “SR” subscript “B”)

1) 8” low frequency driver, 1” high frequency driver, integrated back can
2) Frequency range: 65 Hz – 22 kHz (-10 dB)
3) Sensitivity: 89 dB
4) 95 degree coverage angle (averaged 2 – 10 kHz)
5) All ceiling mounted hardware including tile bridge
6) Provide Soundtube CM82-EZ-II or engineer approved equal

2.6 SWITCHING – MEETING ROOMS

A. Provide a multi format, modular design Digital HDMI matrix switcher. Unit shall deliver a unified HD signal distribution solution incorporating point-to-point wired technology.

1) Provides lossless HD AV signal routing over twisted-pair wire, Integrates video, audio, networking, and control over one wire or fiber strand from any input source, Affords full matrix switching with ultra-high 12.5 Gbps backplane data rate, Handles HDMI® with Deep Color, 3D, 4K, and high-bitrate 7.1 encoded audio, HDBaseT® Certified — Enables direct connection to third-party HDBaseT displays and sources.
2) Provides six (6) HDMI inputs and two (2) HDBaseT-Compatible inputs and two (2) HDMI or HDBaseT-Compatible scaled outputs. Able to manage HDCP keys for fast, reliable switching, technology to achieve rapid switching between disparate sources, Performs automatic AV signal format management via EDID, provides scaling of video outputs. .
3) Basis of design is Extron DTP CrossPoint 82 4K IPCP MA 70 or equal by Crestron or AMX.

2.7 SOURCES

A. Blu Ray Players

1) Unit shall be a single disc player with the following playback formats: BD-ROM, BD-R, BD-E, DVD, DVD+R/RW, DVD-R/RW, CD, CD-R/RW, AVCHD, MP3, JPEG.
2) Unit shall have maximum resolution of 1080p Deep Color via HDMI output, 1080i via component and 480i via composite output.
3) The unit shall be Web enabled with built in WiFi.
4) Unit shall have the ability to be controlled via the IR port.

B. Digital Input Outlets

1) Meeting Rooms
   a) Provide a digital transmitter and switcher that installs in a double-gang electrical box to provide an interface for computers and high-definition AV sources. The unit shall be compatible with HDBaseT™ specifications, allowing it to be connected directly to the input of an HDBaseT compliant display device. The unit shall connect to the head end or display location using standard category rated twisted pair cable, providing HDMI®, VGA, and analog audio inputs, plus a USB HID host port.
   b) Basis of design is Extron DTP T UWP 232 D or equal by Crestron or AMX

2) Tech Room
   a) Provide a digital transmitter and switcher that installs in a double-gang electrical box to provide an interface for computers and high-definition AV sources. The unit shall be compatible with HDBaseT™ specifications, allowing it to be connected directly to the input of an HDBaseT compliant display device. The unit shall connect to the head end or display location using standard category rated twisted pair cable, providing HDMI®, VGA, and analog audio inputs, plus a USB HID host port.
   b) Basis of design is Extron XTP T UWP 202 NL

2.8 CONTROL – MEETING ROOMS

A. Provide an AV system main controller with sufficient ports, processor power, memory and control capability to interface with AV source/display equipment as detailed on the drawings.

1) IR – Provide IR flasher with cabling and connectivity to AV system controller. Provide on sources as indicated on the drawings
2) RS-232 – Provide RS-232 cabling and bi-directional control to AV system controller. Provide on sources as indicated on the drawings.
3) Contact - Provide contact closure with cabling and connectivity to AV system controller. Provide on sources as indicated on the drawings.
4) Ethernet – Provide Ethernet communications with cabling and connectivity to AV systems for touch panel controllers and other items of AV equipment.
5) Basis of design is Extron DTP CrossPoint 82 4K IPCP MA 70 or equal by Crestron or AMX.

B. AV WALL CONTROLLERS

1) Meeting Rooms – Touch Panels
   a) Wall mounted fixed – Minimum 5” color touch screen controller. Thin profile and small footprint, 5” widescreen color display, 800 x 480 WVGA display resolution, Capacitive touch screen technology. Single-
wire Ethernet connectivity, PoE network powered, Includes Mounting Bracket, Available in smooth black or white finish. Coordinate finish with Dayton Library prior to ordering.

b) Provide with manufacturer’s electrical back box (model BB 1).

c) Basis of design is Extron TLP Pro 520M or equal by Creston or AMX.

2) Technology Room – Push Button

a) Provide an AV system main controller with sufficient ports, processor power, memory and control capability to interface with AV source/display equipment as detailed on the drawings.

b) Ethernet monitoring and control

c) (2) bidirectional RS-232 ports

d) (2) internal relays for control of room functions

e) (1) Digital I/O port

f) Discrete ON and OFF display power controls

g) Volume control with volume indicator LED’s

h) Configurable buttons

i) Macro capability

j) Basis of design is Extron MLC PLUS 200 or equal by Creston or AMX.

k) Provide with MFG.’s power supply.

C. Programming - Touch screen controllers shall be programmable with multiple high resolution color graphic “pages” as required to offer controls for each piece of A/V equipment connected to the system within each space. Unit shall be programmed to provide the following controls on the main screen at a minimum:

1) Displays – On/Off, change input/select source, Channel up/dn (on HDTVs)
   a) Projector on lowers lift and screen. Projector off raises lift and screen.

2) Audio – On/Off/Mute/Volume, select source.

3) Sources
   a) Blu Ray – Full unit remote control duplication.
   b) AV Wall input.

2.9 DIGITAL RECEIVER

A. Meeting Rooms

1) Provide a receiver for extension of video/control over longer distances consisting of an HDBaseT compliant system.

2) Extends uncompressed digital video, audio, and control signals up to 230 feet (70 meters) over a category rated twisted pair cable. HDBaseT® Certified, Compatible with HDBaseT sources, Compatible with HDMI® and DVI display devices.

3) Handles Full HD 1080p video with Deep Color and 3D, Handles 4K video resolutions up to 230 feet (70 meters)

4) Supports Dolby® TrueHD, DTS-HD Master Audio™, and uncompressed 7.1 linear PCM audio.

5) Passes CEC, EDID and HDCP

6) IR repeater output

7) Extends bidirectional RS-232 up to 115.2k Baud

8) 24VDC power pack included
9) Basis of design is Extron DTP HDMI 4K 230 Rx or equal by Crestron or AMX.

B. Technology Room

1) Transmits HDMI or analog video, audio, bidirectional RS-232 and IR control up to 330 feet over shielded CATx cable.
2) Handles Full HD 1080p video with Deep Color and 3D. Handles 4K video resolutions.
3) Supports computer and video resolutions up to 4K
4) HDCP 2.2 compliant
5) Passes CEC, EDID and HDCP
6) Basis of design is Extron XTP T UWP 202 4K NL

2.10 POWER INJECTOR

A. Injects 48 volts DC, 0.35 A, 16.8 watts over category cabling.
B. Designed specifically for XTP systems with no impact on signal quality.
C. Status LED’s for real-time monitoring and troubleshooting.
D. UL/c-UL listed and CE compliant.
E. Basis of design is Extron XTP PI 100 or equal by Crestron or AMX.

2.11 ASSISTIVE LISTENING SYSTEM: PROVIDE AN ASSISTIVE LISTENING SYSTEM THAT SHALL CONSIST OF:

A. One (1) stationary FM transmitter capable of broadcasting on 57 channels. The transmitter shall have a SNR of 80 dB or greater. The output power shall be adjustable to quarter, half or full. Channel tuning shall be capable of being locked. The device shall broadcast on both wide and narrow band channels. The device shall have an audio frequency response of 50 Hz to 15kHz, ±3 dB at 72 MHz. It shall have two mixing audio inputs. The device shall have the following audio controls: input level, mix level and an adjustable low pass filter. The device shall have an audio processor that is capable of automatic gain control and limiting. The Listen Technologies model is the basis of design or equals by Williams Sound or Telex. Transmitter antennas are to be within the “line of sight” of the receiver units when they are in use in the intended listening area. If the antennas are not within “line of sight”, a remote antenna kit must be installed, see plan for location. Depending on the distance from the transmitter to the antenna, low loss cable and or a signal booster may be required, follow manufacturers installation requirements. If a remote antenna is to be installed in an area where it could be damaged by sporting equipment, provide a non-metallic safety guard around the antenna. Observe manufactures required mounting distance from all other antennas.

B. A quantity of two (2) receivers shall be capable of receiving on 57 wide and narrow band channels with a SNR of 80 dB or greater. The receiver shall be capable of seeking channels. The device shall have an adjustable squelch. The device shall have an audio frequency response of 50 Hz to 15 KHz, ±3 dB at 72 MHz. The device will incorporate a stereo headset jack that allows the user to plug in either a mono or stereo headset and listen to the audio normally. The device shall incorporate an LCD display that indicates channel, battery level, low battery, battery charging, RF signal strength. The receiver shall incorporate automatic battery charging circuitry for recharging of NiMH batteries. The Listen Technologies model is the basis of design or equals by Williams Sound or Telex. Provide each receiver with dual ear buds (and four (4) sets of spare foam replacement cushions) or a lightweight ear speaker.
C. Provide two (2) induction loop adapters for compatibility with tele-coil equipped hearing aids.

D. Provide a quantity of one (1) 8-Unit Drop in Charger/Carrying Case with removable lid.

2.12 WIRELESS MICROPHONE:

A. Provide one (1) Wireless Microphone System, it shall be a UHF diversity type with handheld microphone/transmitter and a bodypack transmitter with a lavalier microphone. It shall provide dual diversity reception from two external wall/ceiling mounted ½ wave dipole antennas. The receiver shall provide automatic frequency selection with group scan function. A minimum of 1400 selectable frequencies shall be available. It shall feature five-segment LED audio and RF meters, an advance function LCD display and a three-segment transmitter battery gauge. Frequency and volume shall be able to be locked out, once selected. The metal chassis shall be ½-rack-mountable.

B. The handheld transmitter/microphone shall have an 8-hour battery life using a single 9V battery. It shall provide adjustable gain control, three-segment LED battery power indicator, mute and power switches and a grip/switch cover. A backlit LCD display shall show group and channel. Frequency and power settings shall be capable of being locked out. The operating range shall be up to 300 ft. The microphone element shall be a cardioid condenser type. Provide with stand-mount swivel adaptor.

C. The bodypack transmitter shall have an 8-hour battery life using a single 9V battery. It shall provide adjustable gain control, three-segment LED battery power indicator, mute and power switches and a selectable –20dB microphone input pad. A backlit LCD display shall show group and channel. Frequency and power settings shall be capable of being locked out. The operating range shall be up to 300 ft.

D. The wired lavalier electret condenser microphone shall have a rotatable clip, snap-fit foam windscreen and a cardioid pickup pattern

E. Basis of design is Shure Inc. ULXS124/85 or engineer approved equal where shown on drawings.

F. Provide two (2) remote ½-wave antennas with RG8/U cabling (if cabling length exceeds 25’) Basis of design is Shure Inc. UA820 or engineer approved equal where shown on drawings.

G. Frequency selection shall be made with regard to avoiding interference by local television channels and other transmission sources. Consult the manufacturer for help in frequency selection and compatibility.

2.13 ETHERNET CONNECTIVITY – MEETING ROOM

A. The switch shall support full-duplex, 10/100 BASE TX auto-sensing with power over Ethernet (POE) 802.3af to each port. The switch shall be managed and support Remote Power Cycling, CLI, Telnet.

B. Provide rack mounted layer 2 edge switches as required.
2.14 EQUIPMENT RACK – MEETING ROOMS

A. Meeting Room (located in adjacent storage room)

1) Provide an EIA compliant 19”, pivoting, sectional wall mount cabinet.
2) Unit to have 16 rack spaces and a minimum of 20” usable depth.
3) Basis of design is Middle Atlantic DWR-16-20 or engineer approved equal.
4) Provide with locking, vented front door (64% open). Basis of design is Middle Atlantic LVFD-16 or equal.
5) Provide a black, 2 RU drawer from the same manufacturer.
6) Provide a black, vented rackshelf to accommodate Blu-ray player from same manufacturer.
7) Provide a horizontal rackmount, 20 amp, 9 outlet, surge suppressor. Basis of design is Middle Atlantic PD-920R-SP or equal.
8) Note: If separate components are used instead of the all-in-one media presentation switcher, provide a power sequencer so that the audio amplifier will turn on last in the event of a power outage. Approved mfg.’s are Middle Atlantic, Furman, Surgex.

2.15 CABLING

A. Provide all required inter-connect cabling between equipment as required for final system connectivity. All cabling to be new and unused, plenum rated unless installed in conduit the entire length.

1) Wireless microphone antenna cabling listed in that section.
2) Assistive Listening System antenna cabling: use mfg.’s recommended cabling.
3) 70 volt speaker cabling: 18 AWG, copper, twisted pair – West Penn Wire 25224B or equal
4) Control, Mic/Line cabling: 22 AWG, copper, twisted pair with overall foil shield and drain wire – West Penn Wire 25291B or equal
5) Other equipment control cables: shall be stranded wire, appropriately shielded, of gauge and number of conductors in accordance with the recommendations of the systems manufacturer and in compliance with the National Electric Code and local regulations
6) Shielded Twisted Pair cabling for digital AV transmission: (4) unshielded twisted pairs of 24 AWG solid copper conductors with overall shield of Al/Mylar + tinned copper braid (55%) that supports 475 MHz bandwidth at distances up to 330 feet – Extron XTP DTP 24 or equal by Crestron or AMX

2.16 AUDIO/VISUAL PATCH CABLES:

A. Provide all associated A/V patch cables for each equipment item for a fully operational system. All outlets must also be provided with a patch cable for every A/V jack.
B. At a minimum, all items of equipment shall be supplied with a patch cable for each type of input. In some instances, it may be required of the contractor to provide the appropriate adaptors depending on input/output configurations of specific items of equipment.
C. The A/V Contractor shall be responsible for final dressing of all patch cables at each item of equipment to provide a neat and orderly appearance.
PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

   A. Equipment shall be furnished and installed in accordance with manufacturer’s recommendations in compliance with all local, city, state and national codes.

   B. Provide all hardware, framing members, etc. as required for mounting supports.

   C. All penetrations in smoke or firewalls shall be sealed with fire stop rated for this purpose.

   D. The installation of all work shall be neat and of professional quality. Cooperate with other trades in order to achieve well-coordinated progress and satisfactory final results. Execute without claim for extra payment minor moves or changes in equipment locations to accommodate equipment of other trades or the architectural symmetry of the facility.

3.2 AUDIO PROCESSING

   A. At a minimum the following requirements are to be employed:

      1) All audio inputs are to be leveled and set up for unity gain throughout the system gain structure.

      2) Feedback suppression is to be set up on the microphone inputs to eliminate/reduce audio feedback in the system. Compression/limiting and auto gain should also be set up on the microphone inputs as well.

      3) Equalize the microphone input/output to achieve a natural speaking voice.

      4) Set up audio output limiting so that speakers will not be overdriven or damaged.

3.3 TESTS

   A. A qualified technical representative of the system contractor shall do systems acceptance testing. Installation must be complete in all respects before acceptance testing. Acceptance testing and training must be scheduled on separate dates to allow time for corrections, if necessary. Once all functions and devices within the system have been adequately demonstrated to be working properly, a complete owner's manual will be presented to the Owner's agent. It shall contain a comprehensive list of all supplied equipment, a complete point-to-point system wiring diagram with "AS BUILT" wire numbers indicated, details of hook-up connections including build-out devices (active and passive), systems control settings record, the final test results including plotted frequency response curves, operation and maintenance manuals for each active device including schematic diagrams and parts list. A thoroughly completed commissioning checklist (re: InfoComm's AV Installation Handbook Appendix J: Audiovisual Systems Commissioning Tests Checklist) shall be included with the Owner's Manual.

   B. The Contractor shall be prepared to verify the performance of any portion of the system by demonstration, listening tests and/or instrument measurements.
C. Measurement of frequency response, distortion, noise, or other characteristics shall be performed (or a demonstration test requested) if deemed necessary to determine proper operation.

D. The Contractor shall make additional mechanical and electrical adjustments within the scope of the work and which are deemed necessary by the Engineer as a result of acceptance tests.

E. Test Reports and Certification: Submit results of all tests conducted above and certification that the installation is complete and ready for checkout as specified.

3.4 IDENTIFICATION/LABELING

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served.

B. Clearly and permanently label all jacks, controls and connections with engraved laminated plastic labels or with engraved and back-filled mounting plates. Attach laminated plastic labels with contact cement.

C. The contractor shall be responsible for applying a permanent label to each cable to indicate source and destination. Cables shall be tagged at both end and at each point where the cable is administered.

D. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.5 LABELING

A. Identify and permanently label all wires and cables at every point of termination and connection point with industry-standard cable markers. All cable identifications shall be logged, marked on drawings where appropriate and included in the owners’ manual.

3.6 TRAINING

A. Provide step-by-step user instructions identifying operator controls for normal use operations. This shall be included with the O&M manuals.

B. The contractor shall arrange for a total of four (4) hours per room for end user training on the A/V Systems within each room. This training shall be planned and scheduled with the Owner. Training plan shall be pre-approved by the Engineer/Architect and shall include a review of the proposed syllabus.

3.7 PROVIDE FOUR (4) COPIES OF EACH OF THE FOLLOWING:

A. Bound and labeled user manuals and cut sheets for each piece of installed equipment. A complete as-installed equipment list, listed by room, with manufacturers’ names, model numbers, serial numbers and quantities of each item.
B. Bound set of printed CAD drawings for each system. Floor plans, prepared at a scale of not less than 1/8” = 1’-0” showing speaker locations and orientation, wall plates, rack locations and other related device locations.

C. Archived version or electronic copy of editable CAD drawings for each installed system.

D. Electronic copy of uncompiled source code including any processor, touch panel, XPanel and modules installed in the systems and touch panels.

E. Upon completion of the system programming the integrator shall provide The Dayton Library with the uncompiled source code and all modules used in the creation of the program. This shall be completed using the Archive function of the programming software.

F. A complete and correct system schematic, showing detail connections for all parts of the system, including wire numbers, terminal block numbers and layouts and other designations and codings. System performance measurements as noted elsewhere in this specification shall be documented. Include diagrams or charts showing final setting of all control knobs in the system (mixers, equalizers, power amplifiers, etc.)

G. Complete equipment rack/podium layouts showing all rack mounted equipment items.

H. Riser diagrams showing installed conduit with pull boxes, outlet boxes, part number of cable types used, and number of circuits in each conduit.

I. Operations manuals for each and every major equipment item furnished.

J. Copies of any operating and/or setup software.

K. Manufacturer’s warranties and operating instructions for each and every equipment item furnished. Include a copy of the Certificate of Warranty, signed by both parties.

3.8 O & M MANUALS

A. Copies of all approved shop drawings with the Engineer’s stamp.

B. Owner’s manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner’s manuals. CDs containing electronic versions of Owner’s manuals must contain the proper software viewers for each document type.

C. Technology drawings updated with final as-Built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.
D. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

E. Rack elevations for all systems with rack mounted equipment.

F. System Operating Instructions: Provide a clear and concise description of operation which gives, in detail, the information required to properly operate the equipment and system.

G. Provide four (4) copies of each of the following:

1) Bound and labeled user manuals and cut sheets for each piece of installed equipment. A complete as-installed equipment list, listed by room, with manufacturers’ names, model numbers, serial numbers and quantities of each item.

2) Bound set of printed CAD drawings for each system. Floor plans, prepared at a scale of not less than 1/8’’ = 1’0” showing speaker locations and orientation, wall plates, rack locations and other related device locations.

3) Archived version or electronic copy of editable CAD drawings for each installed system.

4) Electronic copy of uncompiled source code including any processor, touch panel, XPanel and modules installed in the systems and touch panels.
   a) Upon completion of the system programming the integrator shall provide The Dayton Library with the uncompiled source code and all modules used in the creation of the program. This shall be completed using the Archive function of the programming software.

5) A complete and correct system schematic, showing detail connections for all parts of the system, including wire numbers, terminal block numbers and layouts and other designations and codings. System performance measurements as noted elsewhere in this specification shall be documented. Include diagrams or charts showing final setting of all control knobs in the system (mixers, equalizers, power amplifiers, etc.)

6) Complete equipment rack/podium layouts showing all rack mounted equipment items.

7) Riser diagrams showing installed conduit with pull boxes, outlet boxes, part number of cable types used, and number of circuits in each conduit.

8) Operations manuals for each and every major equipment item furnished.

9) Copies of any operating and/or setup software.

10) Manufacturer’s warranties and operating instructions for each and every equipment item furnished. Include a copy of the Certificate of Warranty, signed by both parties.

H. Provide statement of warranty with O&M Manuals.

3.9 WARRANTY
A. This Contractor shall warrant all workmanship, equipment and material provided under this contract for a period of one (1) year from the date of approval of certificate of contract completion by the Owner. Provide statement of warranty with O&M Manuals.

B. During the warranty period, report to the site and repair or replace any defective materials or workmanship without cost to the Owner. Warranty service shall be rendered within 24 hours after request by the Owner. Equivalent replacement equipment shall be temporarily provided when immediate on-site repairs cannot be made.

C. Where warranties on individual pieces of equipment exceed twelve months, the guarantee period shall be extended to the warranty period of the particular items.

D. After completion of the work, the Contractor shall submit a Certificate of Warranty, stating commence and expiration dates and conditions of the warranty, for signature of both participating parties. Incremental warranties for complete portions of the work may be negotiated at the discretion of the Owner, if delays occur beyond the control of the Contractor.

END OF SECTION 274116
SECTION 274117 - BROADBAND VIDEO RF DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 SCOPE

A. Work consists of an electronically operated, closed circuit RF distribution system with return path video for local cable television service and distribution. All units of equipment shall be listed by Underwriters' Laboratories. System shall comply with the NEC and CATV Industry Standards.

B. The CATV system shall provide for the distribution of broadband RF signals (5-750 MHz) to and from video outlets utilizing a homerun topology. All units of equipment shall be rated for operation up to 1000 MHz.

C. Applicable References:
   1. National Electric Code (NEC)
   2. Underwriters Laboratories (UL)
   4. Audio Systems Design and Installation (Giddings) 1990
   6. Telecommunications Distribution Methods Manual (TDMM)

1.2 SYSTEM DESCRIPTION

A. Headend Video Components – The system shall consist of broadband distribution amplifiers, splitters, taps, filters, equalizers, etc. to distribute the broadband RF cable TV signal to all outlets within the building.

B. Cabling – The system shall consist of backbone and station coaxial cabling including terminators and terminations to distribute broadband RF cable TV signals to all outlets within the building.

C. Cable Service – The system shall accept input from the local cable television company and from satellite television service and distribute the program content on the in-house broadband RF cable television system.

1.3 QUALITY ASSURANCE

A. Equipment supplier shall have a service organization within 50 miles of the project site. All material and/or equipment necessary for proper operation of the system, not specified or described herein, shall be deemed part of these specifications.

B. The equipment supplier shall have been an authorized distributor of the equipment provided for a minimum of 3 years. The equipment supplier shall provide factory trained technicians for programming, installation support and training of personnel.

C. All system components shall be UL listed.
D. Installation shall be in compliance with the National Electric Code and all other applicable codes.

E. The system shall be in compliance with all FCC Rules and Regulations.

F. All equipment described herein or otherwise required to perform the specified system functions shall be a regular product line, produced by the system manufacturer. Manufacturer shall have produced equipment of compatible features and performance for a period of not less than 5 years (analog) and 2 years (digital).

G. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.

1.4 CONTRACTOR QUALIFICATIONS

A. The Cable Television System shall be furnished and installed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the CATV contractor to utilize a sub-contractor for any portion of the work, unless the Subcontractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.

B. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.

C. The Contractor shall employ factory trained service personnel for the service and maintenance of the system.

D. The Contractor shall have had a minimum of 1 year experience with Broadband CATV systems. This experience shall include having completed a minimum of 2 installations in the past 12 months of similar size and scope. The Contractor shall provide references and contact information for the project sites in which the qualifying installations occurred.

1.5 SHOP DRAWINGS

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

C. Job specific wiring diagrams.

1. This indicates a block diagram that shows all major items of equipment required for the contract project and the actual interconnection that will be installed.

PART 2 - PRODUCTS

2.1 PRODUCT EQUIVALENCY

A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in
writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor’s expense.

B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

2.2 RF Distribution Equipment

A. RF equipment shall be manufactured by Drake, Blonder Tongue, Teradon, Toner, Pico Macom or Jerrold.

B. Broadband Amplifier (Headend) - Provide Indoor Distribution Amplifier, rack/backboard mounted. Amplifiers shall be hybrid design utilizing power doubling. Amplifier shall meet the following performance specifications at a minimum:

1. Forward Gain 43dB
2. Maximum Output Level+ 44dBmV
3. Forward frequency coverage 49 thru 750 MHz
4. Forward gain and slope adjustment controls 10dB/8dB
5. Channel loading 77/110 channel
6. Noise Figure 7.5dB
7. Refer to drawings for quantities and locations. Provide all required equalizer modules to compensate for signal tilt and slope and as required for system balancing and alignment.
8. Provide all plug-ins and condition to manufacturer’s recommended operating levels.

C. Notch Trap - Provide tunable notch traps to remove channels to permit re-insertion of locally generated material. Coordinate channels with the Owner. Unit shall have a pass band of 50-750 MHz and an elimination band as coordinated with required channels to eliminate. Refer to drawings for quantities.

D. Directional Couplers - Provide L style 2/4-way direction couplers with RFI greater than 120dB. Provide required 2/4-way directional couplers rack mounted in video distribution racks or wall mounted on backboards in TC’s as required.

1. Frequency Range: 1000 MHz.
2. 2-port tap off value 4 6 9 12 16 20 24 27 30
   a. Thru line loss(db)
      1) 5-400MHz 3.8 3.0 1.2 0.9 0.7 0.6 0.5 0.5 0.5
      2) 400-900MHz 4.0 3.5 1.6 1.5 0.7 0.7 0.6 0.6 0.6
      3) 900-1000MHz 4.5 4.0 2.0 2.0 1.5 1.5 1.5 1.5 1.5
   b. Isolation Out-totap(dB)
      1) 5-400MHz 20 22 24 30 30 36 36 40 40
      2) 400-1000MHz 18 20 20 24 26 30 30 30 30
3. 4-port tap off value 8 12 16 20 24 27 30
   a. Thru line loss(db)
      1) 5-300MHz NA 3.5 1.5 0.8 0.8 0.7
      2) 5-300MHz NA 3.8 1.8 1.0 0.9 0.9
      3) 5-300MHz NA 4.2 2.5 1.4 1.3 1.2
   b. Isolation Out-totap(dB)
1) 5-300MHz NA 24 28 36 38 43  
2) 300-600MHz NA 26 28 33 35 39  
3) 600-1000MHz NA 25 25 28 32

E. Tri-Plexer - Provide multiplexer to separate sub-band video information for return path video as indicated on drawings.

F. Splitters – Provide digital ready, solder back splitters with RFI greater than 120dB. Provide required 3-way, 4-way and 8-way splitters, rack mounted in video distribution racks or wall mounted on backboards in TC’s as indicated on plans.

1. Frequency Range: 1000 MHz.
2. 2-port loss
   a. 5-500MHz 3.6dB
   b. 500-860MHz 3.8dB
   c. 850-1000MHz 4.2dB
3. 4-port loss
   a. 5-500MHz 7.0dB
   b. 500-860MHz 7.5dB
   c. 850-1000MHz 8.0dB
4. 8-port loss
   a. 5-500MHz 10.5dB
   b. 500-860MHz 11.5dB
   c. 850-1000MHz 12.0dB
5. 2-port Isolation
   a. 5-40MHz 16dB
   b. 40-500MHz 22dB
   c. 500-860MHz 20dB
   d. 860-1000MHz 18dB
6. 4-port Isolation
   a. 5-40MHz 22dB
   b. 40-500MHz 25dB
   c. 500-860MHz 25dB
   d. 860-1000MHz 22dB
7. 8-port Isolation
   a. 5-40MHz 22dB
   b. 40-500MHz 25dB
   c. 500-860MHz 25dB
   d. 860-1000MHz 21dB

G. Terminating resistors with 75 Ohm impedance shall be installed at unused ports and feeder line ends. Terminating resistors shall be designed to cover the frequency range from 5 MHz to 750 MHz with minimum return loss of 25 dB at UHF and 30 dB across the VHF band.

1. Provide terminating resistors at the following as recommended by the manufacturer:
   a. All unused splitter/tap/coupler ports
   b. Amplifier test ports
   c. Unused combiner input/output/test ports.
H. High-Q traps shall be installed where required for the rejection of interfering carriers. Traps shall have an input and output impedance of 75 ohms and connection shall be made through standard "F" connectors. The minimum carrier reflection, when synchronously tuned shall be 50 dB.

I. Provide equalizers as required. The system shall provide for a reverse tilt of no more than 3 dB differential. Line equalizers shall be rated at 750 MHz. They shall have a VSWR of no more than 1.2. The frequency response shall be within .7 dB.

2.3 Coaxial cable shall be 75 ohms nominal impedance and shall be marked with the manufacturer's name. It shall be sweep tested by the manufacturer before shipping and be certified by the tester as such on a tag on each reel. No discontinuity shall exist within TV frequency bands 54-216 MHz and 470-890 MHz on the cable. Attenuation per 100 ft. at VHF channel 13 shall not be greater than 3.6 db. The outer jacket shall be of the non-contaminating type. No cable which shows bruises or shipping damages shall be installed in the system, nor shall any splices or connectors be installed in conduit or any inaccessible place.

A. Video Station Cable: Provided under section 27 15 33 / Provide dual shielded, plenum rated, CATV labeled station cable from each video outlet to distribution equipment in local TC as indicated on drawings:

1. 0-135 ft. – Utilize RG-6
2. 135-300 ft. utilize RG-11
3. Where a room contains both a technology outlet and a video/projector outlet, the incoming video cable shall be connected to a local tap/splitter mounted at the room. Provide additional cables from the tap/splitter to each outlet within the room as required to provide forward and return path video from each outlet.
4. Termination of cable shall be with radial crimp “F” connectors specifically listed for use with the supplied cable. Hex crimp connectors will NOT be acceptable. Terminators shall be screw type. Push-on type connectors will NOT be acceptable.

B. Video Interconnection Cable: Provide shielded, non-plenum rated, factory terminated, Type RG-6 cable between RF distribution equipment within each TC.

1. All interconnecting cables between headend amplifiers and distribution equipment shall be a minimum 12 inches in length.

C. All cable as manufactured by Comm Scope, West Penn, Belden, Carol.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Install systems in accordance with UL, NEC and all other applicable codes. Install system to comply with drawings and final shop drawings in compliance with manufacturer instructions. Provide all required hardware and labor for rack mounting of head-end system components.

B. Refer to plans for locations and quantities of equipment. Equipment locations shown on plans will be required to be field coordinated to ensure proper system operation.
C. No items of equipment shall be installed in such a manner as to void or reduce the proper operating characteristics of individual components or of the system.

D. Perform all work under the on-site supervision of a factory authorized trained technician. It shall be the responsibility of the technician to check, inspect and adjust this installation to the engineer’s and Owner approval. A CSR of the installing contractor or manufacturer shall train the Owner’s personnel on the proper operation and maintenance of the equipment. Perform all work in conjunction with this installation in accordance with good engineering practices as established by NEC.

E. Delivery of all loose equipment which is to be turned over to Owner shall be carefully coordinated and scheduled with Owner prior to shipment.

3.2 WIRING INSTALLATION

A. CATV wiring shall be furnished and installed in accordance with manufacturer’s recommendations in compliance with all Local, State and National codes. This contract shall be responsible for furnishing and installing all required cabling between components to form a complete and operational system meeting all the requirements of this specifications.

B. Provide firestop material and seal all cable penetrations in the building.

C. All wiring between devices shall be run open wired above accessible ceilings. Where existing cable management systems are in place and there is adequate capacity to install the CATV wiring, the contractor may utilize these pathways providing they have coordinated with all other wiring contractor on site. Where multiple runs are required all cables shall be bundled with approved cable ties on four foot centers.

D. Where pathways do not exist for CATV wiring, this contract shall be responsible for providing all required cable management systems such as J-hooks to support communications cabling to meet building codes and manufacturer’s recommendations.

E. Cables shall not be laid upon ceilings or supported in a manner that would violate any codes or standards.

F. All cabling installed in ceiling spaces that are used for air distribution plenums shall be UL plenum rated.

G. All control and signal cable shall be installed continuous and without splices. Provide appropriate connectors or pre-manufactured cables for each application.

H. The use of cable strippers with sharp blades will NOT be accepted.

3.3 TELECOMMUNICATIONS ROOMS

A. The lay-out of the telecommunications rooms as depicted on the drawings shall be utilized as a general guide for bidding purposes. The final room layout shall be carefully coordinated with input from the Owner and from other trades with equipment and/or cabinets to be placed in the room. Final configuration of telecom rooms shall be submitted to Engineer as a coordination drawing with information from all other trades occupying the same room for review prior to permanent mounting of equipment or termination of cabling.
B. Coordinate lay-out of telecom rooms to avoid placing telecommunications equipment and cabinets under water piping (other than sprinkler heads) or HVAC units.

C. Coordinate lay-out of telecom rooms with electrical plans and locations of electrical outlets.

D. Lay-out of telecommunications equipment cabinets and racks shall provide a minimum of 36 inch isle in front and behind equipment racks and cabinets which is clear of obstructions or equipment protrusions.

E. Within the various telecom rooms, coordinate rack locations and orientation to maintain required clearances including any equipment depths that may have to be accounted for. Some equipment, such as servers and UPS units may have special mounting requirements that need additional coordination.

3.4 GROUNDING

A. The installing contractor shall be responsible for ensuring the grounding integrity of all installed equipment to eliminate the potential for equipment or personnel hazards due to improperly or inadequately grounded systems.

B. All grounding and bonding shall be in conformance with the National Electric Code, article 250 and as recommended by EIA/TIA-607.

C. The Division 26 Contractor has provided 120V branch circuitry for use by the CATV system contractor. The branch circuitry is run with a dedicated equipment grounding conductor which shall be utilized by the CATV system equipment. In no case shall the CATV system installation compromise the integrity of the Building Electrical Grounding System.

3.5 PROGRAMMING

A. It is the Contractor’s responsibility to program the system in this section according to the Owner’s wishes. This includes the set up and assignment of channels, coordination of services, etc. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming. This programming agreement shall then be written out in detail and forwarded to the Engineer for approval. After approval is granted, proceed with final programming.

3.6 IDENTIFICATION/LABELING

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.

B. The Contractor shall be responsible for labeling all supplied equipment racks, cable jacks, etc. in accordance with the guidelines as described herein. The end of each cable, each jack, patch panel, cross-connect and rack/backboard shall be identified and permanently recorded on 8.50 X 11 sheets attached to each rack/backboard.

C. Each cable, jack cross-connect and patch panel shall be labeled at every location where they are administered per established industry standards.
D. Create a detailed record sheet for each backbone cable. Record shall indicate connection rack / backboard, patch panel / cross-connect and jack / port, at both ends, for each cable within each backbone cable assembly.

E. Create a detailed records sheet for the station cabling including floor plans showing outlet locations and which jacks are in which outlet. Records shall indicate connection rack/backboard, patch panel / cross-connect and jack / port, at both ends, for each cable.

F. The contractor shall be responsible for generating and programming the labeling for camera information within the recorder software.

G. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.7 TESTING

A. System shall be tested end-to-end complete by and a certificate of inspection shall be furnished by a qualified manufacturer's representative or equipment vendor; submit report to the Architect.

B. Provide system alignment and balancing prior to system testing. Alignment and balancing shall match the specified signal levels and impedance within the system.

C. This Contractor shall provide the following tests with results to indicate conformance with the specifications at each outlet:

1. End Of Line Receive Level at Channels 7, 24, 65

D. All test equipment and qualified labor shall be included in this contract. The installer must be proficient in the use of all required test equipment.

E. All tests shall be witnessed by the Architect/Engineer/Owner and shall be electronically recorded. Provide a hard copy of each outlet test result for inclusion in the O&M Manuals.

3.8 CABLE/SATELLITE SERVICE

A. Provide all labor and material required to make all final connections to the Cable Television Company and the Satellite Television Company service provider(s) Demarcation location and equipment. Coordinate with Owner selected service provider(s).

3.9 TRAINING REQUIREMENTS

A. Provide all training and utilize specified manuals and record documentation. Training shall be provided to all staff at the project site and coordinated with the Owner. Provide two (2) video copies of training.

B. Training shall include multiple four-hour sessions encompassing all instructions required for system operation. Provide operators manuals and user guides with training. Provide follow up training after initial training. Provide a total of eight (8) hours of system training to the Owner.
C. Training shall utilize the equipment provided at the project site. Coordinate use, time and availability of equipment with the Owner.

D. Demonstrate adjustment, operation and maintenance of the system including each component and control.

3.10 SYSTEM ACCEPTANCE REQUIREMENTS

A. The CATV distribution system shall exceed these minimum requirements:

1. End Of Line Receive Level - 0-10 dBmV (as measured at the outlet over the entire video spectrum range.)

B. All connectors, taps and patch cables must meet all CATV and SMATV requirements for RF shielding.

C. The entire system shall comply with the radiation limitations as set forth under the FCC Rules.

D. These specifications shall be valid for the range of channels in the 54-750 MHz band.

3.11 AS-BUILT DOCUMENTATION

A. Copies of all approved shop drawings with the Engineer’s stamp.

B. Owner’s manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner’s manuals. CDs containing electronic versions of Owner’s manuals must contain the proper software viewers for each document type.

C. Technology drawings updated with final as-Built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.

D. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

E. This Contractor shall provide the following tests with results to indicate conformance with the specifications at each outlet:

1. End Of Line Receive Level

F. Provide warranty information with the O&M manuals.

3.12 WARRANTY

A. Warrant all workmanship, equipment, material and software entering into this contract for a period of three (3) years from date of final acceptance or date of beneficial use, as agreed to
between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Provide a statement of this warranty with the O & M Manuals.

END OF SECTION 274117
SECTION 274119 - VIDEO DISPLAY EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE

A. The work described by this section includes the furnishing of all components, materials, equipment, installation and technical labor and the performance of all operations necessary for the complete installation of an audio visual system in operating condition as indicated on the drawings and/or specified herein.

B. The drawings show the intent and scope of the AV systems. The specifications include product data for the major items of equipment and means/methods for installation. The contractor will be responsible for a complete and operating system, which may require additional accessories, parts, fittings, patch cables, etc. for a final installation.

C. Included in the Scope of this Section:
   1. Provision of submittal information
   2. Installation in accordance with contract documents, manufacturers’ recommendations and applicable codes
   3. Programming and configuration of control and signal processing software
   4. Testing and adjustments, including documentation thereof
   5. Provision of manuals
   6. Maintenance and warranty services

D. Applicable References:
   1. National Electric Code (NEC)
   2. Underwriters Laboratories (UL)
   4. Telecommunications Distribution Methods Manual (TDMM)

1.2 DESCRIPTION OF WORK

A. Refer to the drawings for quantity and location of AV equipment and configuration of system connectivity and wiring.

B. AV system cabling as detailed on the drawings and as specified herein.

1.3 QUALITY ASSURANCE

A. All system components shall be UL listed.

B. Installation shall be in compliance with the National Electric Code and all other applicable codes.

C. All equipment described herein or otherwise required to perform the specified system functions shall be a regular product line, produced by the system manufacturer.
D. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.

1.4 CONTRACTOR QUALIFICATIONS

A. The A/V equipment package shall be furnished and installed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the A/V contractor to utilize a Subcontractor for any portion of the work, unless the Subcontractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.

B. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.

C. Equipment supplier shall have a service organization within 75 miles of the project site.

D. The Contractor shall employ factory trained service personnel for the service and maintenance of the system.

1.5 SHOP DRAWINGS

A. A complete and comprehensive list of materials with quantity, manufacturer, model and part number and reference to the Part 2 specification paragraph number for each item.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

C. Job specific diagrams.

PART 2 - PRODUCTS

2.1 PRODUCT EQUIVALENCY

A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor’s expense.

B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

2.2 HDTV FLAT PANEL DISPLAYS

A. Wide-screen, LED flat panel, high definition display with 16:9 aspect ratio, 1920 x 1080p x4 sub pixels native display resolution, minimum 120Hz refresh rate, minimum requirement.

1. Display Formats: 480i, 480p, 1080i, 1080p_60, 1080p_24, 1080p_30
2. A/V inputs (Refer to drawing schedule for required quantities of each.)
   a. Composite video + L/R audio (RCA jacks)
b. HD Component (Y,Pb,Pr) + L/R audio (RCA jacks)
c. VGA/RGB (15-pin HD) + L/R audio
d. HDMI 1.3/HDCP
e. USB
f. Stereo audio

3. A/V Outputs (Refer to schedule for required quantities of each.)
   a. HDMI 1.3/HDCP
   b. Digital Audio (Optical, Coax)
c. Analog audio – variable line level
d. Other Inputs/Outputs
e. RS-232 (Control/Setup/Service)

4. ATSC Tuners with Clear QAM must support all FCC compliant analog and digital broadcasts.

5. All functions shall be IR remote controllable.

6. Provide a remote control with each unit.

7. Refer to drawings for nominal display sizes.

8. HDTV monitor shall be a “Commercial Grade”.

2.3 FLAT PANEL DISPLAY MOUNTS & ENCLOSURES

A. Mount

1. Wall mounts shall be supplied for displays. Provide all required supporting hardware as required by field conditions. Verify structural integrity of mounting location.
2. Wall mounts shall utilize an adjustable minimum 5 degree forward tilt.
3. Coordinate location and elevation of wall mounts with Architectural elevations and room furnishings.
4. Wall mounts for digital signage displays shall be tilt and swivel with the bottom of the monitor a minimum of 84” AFF.

B. Outlet Boxes

1. Provide recessed outlet box for AV system cabling and power. Box to include steel backbox, front cover with cable openings, multiple knockouts, and be UL listed for AC.
2. Provide AV system connectivity including video jacks, audio jacks, and Ethernet jacks as detailed on the drawings.
3. FSR PWB100 or approved equal.

2.4 DIGITAL VIDEO PROJECTORS - PROVIDE AND INSTALL THE FOLLOWING TYPES OF PROJECTORS:

A. Ceiling Mounted – Large Meeting Room

1. Digital Video Projector with native resolution WUXGA (16:10) 1920x1200/HD (16:9) 1920x1080/WXGA (16:9) 1280x800, capable of supporting up to WXGA (1920 x 1200) resolution with image resizing.
3. Inputs
   a. Digital - DVI-D, HDMI
   b. Analog (with audio)- RGB; composite video, S-video.
   c. Control – LAN, RS-232
4. Outputs
   a. Analog - RGB
5. Contrast Ratio minimum of 2000:1
6. Lens
   a. Full range of field interchangeable zoom lenses. Lens selection to be sized to accommodate projector setback and screen size to provide maximum image size on screen.
   b. Lens Shift (minimum): +/- 20 degrees (V), 70 degrees (H)
   c. Keystone correction (minimum): +/- 20 degrees (H), +/- 30 degrees (V)
   d. Scanning Frequency Range: Pixel Clock – 13.5 up to 165MHz; Horiz. 15KHz to 80KHz; Vert. 24/30/50/60 (digital), 50Hz to 85Hz (analog)
7. Power Consumption: 720W (5.5W standby)
8. IR remote control, Electronic “standby” mode accessible through the remote control. Cycling of power to the unit while in “standby” mode shall not cause the unit to switch to “on” mode with lamp burning.
9. Projector must be IP capable with network access for remote diagnostics, Lamp life indicator and file up/down load capabilities through remote software.
10. Coordinate mounting height and location of projector to provide full video image on screen. Provide all necessary power and signal cables required to operate the projector.
11. Projectors as manufactured by Canon, Epson, NEC, Panasonic.

B. Ceiling Mounted – Small Meeting Room, Technology Room, and Opportunity Space

1. Digital Video Projector with native resolution WUXGA (16:10) 1920x1200/HD (16:9) 1920x1080/WXGA (16:9) 1280x800, capable of supporting up to WXGA (1920 x 1200) resolution with image resizing.
3. Inputs
   a. Digital - DVI-D, HDMI
   b. Analog (with audio)- RGB; composite video, S-video.
   c. Control – LAN, RS-232
4. Outputs
   a. Analog - RGB
5. Contrast Ratio minimum of 2000:1
6. Lens
   a. Full range of field interchangeable zoom lenses. Lens selection to be sized to accommodate projector setback and screen size to provide maximum image size on screen.
   b. Lens Shift (minimum): +/- 20 degrees (V), 70 degrees (H)
   c. Keystone correction (minimum): +/- 20 degrees (H), +/- 30 degrees (V)
   d. Scanning Frequency Range: Pixel Clock – 13.5 up to 165MHz; Horiz. 15KHz to 80KHz; Vert. 24/30/50/60 (digital), 50Hz to 85Hz (analog)
7. Power Consumption: 720W (5.5W standby)
8. IR remote control, Electronic “standby” mode accessible through the remote control. Cycling of power to the unit while in “standby” mode shall not cause the unit to switch to “on” mode with lamp burning.
9. Projector must be IP capable with network access for remote diagnostics, Lamp life indicator and file up/down load capabilities through remote software.
10. Coordinate mounting height and location of projector to provide full video image on screen. Provide all necessary power and signal cables required to operate the projector.
11. Projectors as manufactured by Canon, Epson, NEC, Panasonic.
2.5 PROJECTOR MOUNTS

A. Ceiling Mount

1. Provide a universal projector mount with the following minimum adjustments:
   a. Pitch: +5/-20-degree
   b. Roll: +/- 1-degree
   c. Swivel: 360-degree
2. Peerless model PRS-UNV
4. Provide an attachable swivel mount in locations with sloped ceilings. Peerless model ACC912.
5. Extension column(s) (1-1/2-inch diameter) as required to position the projector at the required mounting height.
6. Equal manufacturers: Chief, Premier

2.6 PROJECTOR CEILING BOX

A. 2’x2’ plenum rated enclosure with two full rack spaces for equipment, five switched AC outlets and a 1-1/2” NPT fitting to hang projector from. Basis of design is FSR Inc. model CB-22P or equal by premier, Chief. Provide with appropriate length downtube. Coordinate color with architect.

B. Provide with MFG.’s cable or threaded rod mounting kit, install per MFG.’s mounting recommendations.

2.7 Surge Suppressors (for all display devices): The surge suppressor shall be a compact mountable unit in a magnetic shielding steel enclosure. It shall operate from 120 volts AC and include a separate 3-foot, grounded, 3-wire #18 line cord. There shall be 2 grounded AC receptacles. Overall dimensions shall be 1.75 inches H x 5.31 inches W x 9.06 inches D. Weight shall be 3.4 pounds. It shall have a load rating of 8 amps @ 120 volts. It shall be listed to UL 1449-2 and certified to Federal Grade A, Class 1, Mode 1 Guidelines for powerline surge suppressors. The unit shall provide auto-resetting overvoltage shutdown. There shall be three limiter circuits: a series surge reactor current limiter, a cascaded auto-tracking dual-polarity voltage limiter, and a pulse inverter. The onset clamping voltage shall be 172 volts nominal, and the unit shall have an instant-reacting snubber to protect against fast-rising surges generated within the installation location. The surge suppressor shall have an unlimited Applied Surge Current rating (8 x 20 µs) and shall withstand at least 1000 occurrences of Surge Pulse Voltages up to 6000 volts. Provide a Surgex model SA82 Flatpak for each flat panel monitor and projector. No substitutes.

2.8 PROJECTION SCREEN

A. Provide an electrically operated, wall/ceiling-mounted, front-projection screen.

1. The electrically operated, mounted screen shall have a motor mounted inside the roller, oiled for life, automatic thermal overload cutout, integral gears, and electric brake to prevent coasting. It shall provide the following features:
2. Aspect Ratio: 16:10
3. Screen Size: As noted on drawings.
4. Screen Fabric: High Contrast matte white finish, 50 degree viewing angle and 1.1 gain. Screen fabric to be seamless, flame retardant and mildew resistant vinyl, with black masking borders standard.
5. Provide minimal drop to place the bottom of the viewable portion of the screen within the sight line of as many viewers as possible.
6. Rigid metal roller.
7. Screen case shall be a two piece design made of extruded aluminum, coordinate color prior to ordering.
8. A junction box shall be internally integrated into the housing making it possible to install the housing and wire to the building’s electrical system during construction. The junction box shall contain a quick connect connector that is mounted in the housing for easy plug-in connection to the motorized fabric and roller assembly.
9. The motorized fabric and roller assembly to be installed in the case at the factory or at a later time at the job site.
10. Integrated low voltage control unit wired to room AV control system.
   a. Large Meeting Room
      1) Provide a 87”x 139” DA-LITE Contour Electrol with wall mounting hardware or approved equal. Provide with screen drop to position bottom of image at 48” AFF. Coordinate color with owner and architect.
   b. Technology Room
      1) Provide a 50”x 80” DA-LITE Contour Electrol with wall mounting hardware or approved equal. Provide with screen drop to position bottom of image at 48” AFF. Coordinate color with owner and architect.
   c. Small Meeting Room
      1) Provide a 50”x 80” DA-LITE Advantage Electrol with ceiling mounting hardware or approved equal. Provide with screen drop to position bottom of image at 48” AFF. Coordinate color with owner and architect.
   d. Opportunity Room
      1) Provide a 69”x 110” DA-LITE Advantage Electrol with ceiling mounting hardware or approved equal. Provide with screen drop to position bottom of image at 48” AFF. Coordinate color with owner and architect.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

   A. Equipment shall be furnished and installed in accordance with manufacturer’s recommendations in compliance with all local, city, state and national codes.

   B. Provide all hardware, framing members, etc. as required for mounting supports.

   C. All penetrations in smoke or firewalls shall be sealed with fire stop rated for this purpose.

   D. The installation of all work shall be neat and of professional quality. Cooperate with other trades in order to achieve well-coordinated progress and satisfactory final results. Execute without claim for extra payment minor moves or changes in equipment locations to accommodate equipment of other trades or the architectural symmetry of the facility.

3.2 PROJECTOR INSTALLATION
A. Contractor shall field verify the location of projector, structural elements at the proposed mounting location, and the scree/lens combination to ensure proper installation prior to mounting equipment. Where field conditions will not provide the correct application for the proposed projector type/location/mounting method, the contractor shall notify the Engineer/Architect in writing. Notification shall include proposed alternatives for review.

B. Projectors shall be mounted straight, level and true and shall provide the desired image size/orientation on the projection surface.

C. Contractor shall custom configure the projector video/image/setting menus once source equipment and AV system is operational. Projector set-up shall be completed and the optimal settings stored for later recall.

D. Programming of projectors and centralized projector control software including all network assignments, passwords, schedules, etc.

3.3 FLAT PANEL INSTALLATION

A. Contractor shall field verify the location of each flat panel with surrounding structural elements and room furnishings at the proposed mounting location to ensure proper installation prior to mounting equipment. Where field conditions will not provide the correct application for the proposed flat panel type/location/mounting method, the contractor shall notify the Engineer/Architect in writing. Notification shall include proposed alternatives for review.

B. Flat panel displays shall be mounted straight, level and true.

C. Contractor shall custom configure the flat panel video/image/setting menus once source equipment and AV system is operational. Flat Panels with tuners shall have the broadband CATV channels scanned and programmed once the system is active. Flat panel set-up shall be completed and the optimal settings stored for later recall.

D. Programming of flat panels and centralized AV control software including all network assignments, passwords, schedules, etc.

3.4 TESTS

A. Upon completion of installation and satisfactory testing of system by Contractor in presence of the equipment supplier, the Contractor shall test the system in the presence of the Owner and the Engineer to demonstrate satisfactory performance.

B. System shall be tested by and a certificate of inspection shall be furnished by a qualified manufacturer’s representative or equipment vendor; Submit report indicating result to the Engineer.

3.5 IDENTIFICATION/LABELING

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both end and at each point where the cable is administered.
B. The contractor shall be responsible for applying a permanent label to each cable to indicate source and destination.

C. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.6 TRAINING

A. Provide step-by-step user instructions identifying operator controls for normal use operations. This shall be included with the O&M manuals.

B. The contractor shall arrange for a total of twenty four (24) hours for end user training on the various A/V Systems. This training shall be planned and scheduled with the Owner. Training plan shall be pre-approved by the Engineer/Architect and shall include a review of the proposed syllabus.

3.7 O & M MANUALS

A. Copies of all approved shop drawings with the Engineer’s stamp.

B. Owner’s manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner’s manuals. CDs containing electronic versions of Owner’s manuals must contain the proper software viewers for each document type.

C. Technology drawings updated with final as-built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.

D. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

E. Rack elevations for all systems with rack mounted equipment.

F. System Operating Instructions: Provide a clear and concise description of operation which gives, in detail, the information required to properly operate the equipment and system.

G. Provide statement of warranty with O&M Manuals.

3.8 WARRANTY

A. Warrant all workmanship, equipment, material and software entering into this contract for a period of one (1) year from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Provide a statement of this warranty with the O & M Manuals.
B. During the warranty period, report to the site and repair or replace any defective materials or workmanship without cost to the Owner. Warranty service shall be rendered within 24 hours after request by the Owner. Equivalent replacement equipment shall be temporarily provided when immediate on-site repairs cannot be made.

C. Where warranties on individual pieces of equipment exceed one (1) year, the guarantee period shall be extended to the warranty period of the particular items.

D. After completion of the work, the Contractor shall submit a Certificate of Warranty, stating commence and expiration dates and conditions of the warranty, for signature of both participating parties. Incremental warranties for complete portions of the work may be negotiated at the discretion of the Owner, if delays occur beyond the control of the Contractor.

END OF SECTION 274119
SECTION 274125 - DIGITAL SIGNAGE SYSTEM

PART 1 - GENERAL

1.1 GENERAL

A. These specifications shall be utilized for the expansion of the existing Tight-Rope system as specified herein and as shown on the bid documents.

1.2 SCOPE OF WORK

A. Remote displays shall utilize a network of small form factor WAN/LAN connected Digital signage players at each display capable of supporting all major media formats via a local HDMI port supporting minimum 720p resolution.

B. Digital Signage players shall also provide RS-232 control interface with local display for management control including power, volume, input selection, etc.

1.3 QUALITY ASSURANCE

A. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. The Contractor shall provide factory trained technicians for programming, installation support and training of personnel.

B. Contractors must produce written documentation indicating the following:

1. They are or are in the process of becoming a trained and certified dealer of the specified system. This implies that they have made the commitment to receive technical training on all aspects of the system including installation, integration, programming and operation. This training shall be such that routine service calls can be performed by this Contractor by providing local technical support.

2. They are or are in the process of maintaining a limited stock of hardware such as set-top boxes, media source controller, modulators, etc. so that routine service calls can be performed without the need for cross-country shipping of parts.

3. They have the ability to offer the Owner an extended service contract for the system.

C. All system components shall be UL listed.

D. Installation shall be in compliance with the National Electric Code and all other applicable codes.

E. The system shall be in compliance withal FCC Rules and Regulations.

F. All equipment described herein or otherwise required to perform the specified system functions shall be a regular product line, produced by the system manufacturer.

1.4 CONTRACTOR QUALIFICATIONS

A. The Informational Delivery System shall be furnished and installed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the IDS contractor to utilize a
sub-contractor for any portion of the work, unless the sub-contractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.

B. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.

C. The Contractor shall employ factory trained service personnel for the service and maintenance of the system.

D. The Contractor shall have had a minimum of 1 year of experience with Ip based On Demand IDS systems. This experience shall include having completed a minimum of 1 installation in the past 12 months of similar size and scope. The Contractor shall provide references and contact information for the project sites in which the qualifying installations occurred.

1.5 SHOP DRAWINGS

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

C. Qualifications

1. A statement of contractor’s qualifications to verify compliance with other provisions within the specifications, unless the contractor has been pre-approved.

PART 2 - PRODUCTS

2.1 System shall be as manufactured by Tightrope Media Systems. All material and/or equipment necessary for proper operation of the system not specified or described herein shall be deemed part of these specifications.

2.2 DIGITAL SIGNAGE PLAYER

A. Hardware to be small form factor unit, totally enclosed and ventilated, designed to mount behind the associated flat panel display. Unit shall have USB port for local keyboard/mouse connection to assist in local programming and set-up.

B. Unit shall incorporate 10/100 ethernet connectivity.

C. Unit shall provide HDMI video port supporting up to 1920x1080 resolution.

D. Unit shall provide control port to interface with display for remote management and control including power on/off, volume, input select, etc.

E. Player shall be Tightrope Media Systems “Carousel 260”
2.3 PATCH CABLES

A. Provide all required A/V and control patch cables at each display to fully connect player to distribute audio and video content in HD and to provide full system control of display.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Digital Signage Players shall be securely mounted at each display utilizing equipment and hardware made for the purpose.

B. Rack mounted equipment shall be installed in equipment racks utilizing proper rack mounting hardware and in a way that provides adequate access to equipment as well as ventilation.

3.2 WIRING INSTALLATION

A. All patch cables provided for system connectivity shall be neatly installed and provided with cable management accessories to organize and minimize the visibility of the connecting cables.

B. Provide all required audio, video and control cabling from remote players to the display they are associated with.

C. All wiring entering/leaving racks or cabinets shall be properly routed and secured. Wires and cables used in assembling racks or cabinets shall be formed into harnesses which are tied and supported for proper strain relief. Harnessed cables shall be combed straight. Each cable that breaks out from the harness for termination shall be provided with an ample service loop and shall not violate the minimum bend radius of the cable.

3.3 PROGRAMMING

A. It is the Contractor’s responsibility to program the system in this section according to the Owner’s wishes. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming. This programming agreement shall then be written out in detail and forwarded to the Engineer for approval. After approval is granted, proceed with final programming.

B. Provide programming of Digital Signage Players for network connectivity (IP Addressing, VLAN, routing, etc.) and control compatibility of local displays (codes for display function controls).

C. Assist the owner in developing the overall system programming templates for control, scheduling, distribution, etc.

3.4 IDENTIFICATION/LABELING

A. Contractor shall identify and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered. All control and signal cables shall be installed continuous and without splices. Provide appropriate connectors or pre-manufactured cables for each application.
3.5 TESTS

A. Each display shall be tested and verified to receive and display the full range of digital signage content including static and dynamic content, emergency alert messages, live-video, video in overlay windows, “tickers” or bulletins, and audio content.

B. Each display shall be tested and verified to be fully controlled by the centralized media management system. Tests shall demonstrate controls of the following aspects at a minimum; Power on/off, volume up/dn/mute, input select.

C. Web based access with user account limitations shall be demonstrated.

3.6 AS-BUILT DOCUMENTATION

A. The Contractor shall furnish the Owner two (2) complete bound as-built manuals in an 8.50 inches x 11 inches format. Drawings shall be a minimum of 11 inches x 17 inches engineering format. These manuals shall be assembled in a loose leaf binder and shall contain:

1. Component Service Manuals

3.7 WARRANTY

A. Warrant all workmanship, equipment, material and software entering into this contract for a period of three (3) years from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Provide a statement of this warranty with the O & M Manuals.

B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

C. The Contractor shall be responsible to provide service during normal working hours within (8) hours after notification by the Owner for normal service or within (4) hours for emergency service. Emergency service is defined as the loss of 25 percent or more of system component operation, or the loss of the main server.

D. If equipment cannot be repaired within 24 hours of service visit. Contractor shall provide “loaner” equipment to the Owner at no charge.

E. Proper identification is required and must be visible while on-site for warranty / service calls. Provide notification of completion to the Owner prior to departing the site.

END OF SECTION 274125
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetallic conduits, tubing, and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Metal wireways and auxiliary gutters.
5. Nonmetallic wireways and auxiliary gutters.
8. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
2. Section 260533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.
3. Section 270528 "Pathways for Communications Systems" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving communications systems.

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid steel conduit.

C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

D. Samples: For wireways and surface pathways and for each color and texture specified, 12 inches (300 mm) long.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of pathway groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Seismic Qualification Certificates: For pathway racks, enclosures, cabinets, and equipment racks and their mounting provisions, including those for internal components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.

D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers:
1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a part of Atkore International.
3. Alpha Wire.
4. Anamet Electrical, Inc.
5. Electri-Flex Company.
6. O-Z/Gedney; a brand of Emerson Industrial Automation.
7. Picoma Industries, Inc.
8. Republic Conduit.
10. Southwire Company.
12. Western Tube and Conduit Corporation.

B. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. ARC: Comply with ANSI C80.5 and UL 6A.

E. IMC: Comply with ANSI C80.6 and UL 1242.

F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch (1 mm), minimum.

G. EMT: Comply with ANSI C80.3 and UL 797.

H. FMC: Comply with UL 1; zinc-coated steel.

I. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

J. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:
   a. Material: Steel or die cast.
   b. Type: Setscrew or compression.
3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 467, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

K. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Manufacturers:

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a part of Atkore International.
3. Anamet Electrical, Inc.
5. CANTEX, Inc.
6. CertainTeed Corporation.
8. Electri-Flex Company.
10. Lamson & Sessions.
11. Niedax, Inc.
12. RACO; Hubbell.

B. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

C. ENT: Comply with NEMA TC 13 and UL 1653.

D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

E. LFNC: Comply with UL 1660.

F. Rigid HDPE: Comply with UL 651A.

G. Continuous HDPE: Comply with UL 651B.

H. RTRC: Comply with UL 1684A and NEMA TC 14.

I. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

J. Fittings for LFNC: Comply with UL 514B.
K. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

L. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

A. Manufacturers:
   1. Alpha Wire.
   2. Arnco Corporation.
   3. Endot Industries, Inc.
   4. IPEX USA, LLC.
   5. Lamson & Sessions.

B. Description: Comply with UL 2024; flexible-type pathway, approved for plenum installation unless otherwise indicated.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-B.

2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers:
   2. Hoffman; a brand of Pentair Equipment Protection.
   3. MonoSystems, Inc.
   4. Square D.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
   1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-B.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.
2.5 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers:
   1. Allied Moulded Products, Inc.
   2. Hoffman; a brand of Pentair Equipment Protection.
   3. Lamson & Sessions.
   4. Niedax, Inc.

B. General Requirements for Nonmetallic Wireways and Auxiliary Gutters:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-B.

C. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

D. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

E. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

F. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 SURFACE PATHWAYS

A. General Requirements for Surface Pathways:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-B.

B. Surface Metal Pathways: Galvanized steel with snap-on covers complying with UL 5. Prime coated, ready for field painting.
   1. Manufacturers:
      a. MonoSystems, Inc.
      b. Niedax, Inc.
c. Panduit Corporation.
d. Wiermold/Legrand.

C. Surface Nonmetallic Pathways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

1. Manufacturers:
   a. Lamson & Sessions.
   b. MonoSystems, Inc.
   c. Panduit Corporation.
   e. Wiremold/Legrand.

2.7 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers:

1. Adalet.
3. EGS/Appleton Electric.
5. Hoffman; a brand of Pentair Equipment Protection.
7. Milbank Manufacturing Co.
8. Molex Premise Networks.
12. RACO; Hubbell.
13. Rebroy Industries.
14. Spring City Electrical Manufacturing Company.
15. Stahlin Non-Metallic Enclosures.
17. Wiremold/Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-B.
2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
E. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

F. Metal Floor Boxes:
   1. Material: Cast metal.
   2. Type: Fully adjustable.
   3. Shape: Rectangular.
   4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

I. Device Box Dimensions: 4-inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).

J. Gangable boxes are allowed.

K. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

M. Cabinets:
   1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.
   6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.8 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING

A. General Requirements for Handholes and Boxes:
   1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
   2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Comply with TIA-569-B.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass or a combination of the two.

1. Manufacturers:
   a. Armorcast Products Company.
   b. Carson Industries, LLC.
   c. NewBasis.
   d. Oldcastle Precast, Inc.
   e. Quazite: Hubbell Power Systems, Inc.
   f. Synertech Moulded Products.

2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC."
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of polymer concrete.

1. Manufacturers:
   a. Armorcast Products Company.
   b. Carson Industries, LLC.
   c. NewBasis.
   d. Nordic Fiberglass, Inc.
   e. Oldcastle Precast, Inc.
   g. Synertech Moulded Products.

2. Standard: Comply with SCTE 77.
4. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
7. Cover Legend: Molded lettering, "ELECTRIC."
8. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
9. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.9 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC.
2. Concealed Conduit, Aboveground: GRC.
3. Underground Conduit: RNC, Type EPC-80-PVC, direct buried.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:
   a. Mechanical rooms.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric-Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC.
7. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, communications-cable pathway or EMT.
8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250.
C. Minimum Pathway Size: 3/4-inch (21-mm) trade size. Minimum size for optical-fiber cables is 1 inch (27 mm).

D. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew or compression, fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

B. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

C. Complete pathway installation before starting conductor installation.

D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications wiring conduits for which only two 90-degree bends are allowed. Support within 12 inches (300 mm) of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches (300 mm) of enclosures to which attached.

I. Pathways Embedded in Slabs:
1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
3. Arrange pathways to keep a minimum of 1 inch (25 mm) of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to GRC before rising above floor.

J. Stub-ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for pathways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

N. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to conduit assembly to assure a continuous ground path.

P. Cut conduit perpendicular to the length. For conduits of 2-inch (53-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

Q. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.

R. Surface Pathways:
1. Install surface pathway for surface electrical outlet boxes only where indicated on Drawings.
2. Install surface pathway with a minimum 2-inch (50-mm) radius control at bend points.
3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
S. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch (21-mm) Trade Size and Smaller: Install pathways in maximum lengths of 50 feet (15 m).
2. 1-Inch (27-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

T. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.

U. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

V. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

W. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
   c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
   d. Attics: 135 deg F (75 deg C) temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115
mm per meter of length of straight run per deg C) of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

X. Flexible Conduit Connections: Comply with NEMA RV 3. Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
   1. Use LFMC in damp or wet locations subject to severe physical damage.
   2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

Y. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

Z. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

AA. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

BB. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

CC. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

DD. Set metal floor boxes level and flush with finished floor surface.

EE. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
   1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
   2. Install backfill as specified in Section 312000 "Earth Moving."
   3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and
complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."

4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of elbow.

5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits, but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.

7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HAN DHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install handholes with bottom below frost line, 42 inches (1067 mm) below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS
A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electronic Safety and Security Pathways and Cabling."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 28 05 28
SECTION 28 05 44 - SLEEVES AND SLEEVE SEALS FOR
ELECTRONIC SAFETY AND SECURITY PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
   2. Sleeve-seal systems.
   5. Silicone sealants.

B. Related Requirements:
   1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
   2. Penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
   1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
   2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 2 - PRODUCTS

2.1 SLEEVES
A. Wall Sleeves:
   2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
      b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Manufacturers:
   a. Advance Products & Systems, Inc.
   b. CALPICO, Inc.
   c. Metraflex Complex (The).
   d. Pipeline Seal and Insulator, Inc.
   e. Proco Products, Inc.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Carbon steel.

4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.
2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers:
   a. HOLDRITE.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.


C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Silicone Foams: Multicomponent, silicone-based, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.
C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
   a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
   b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using [steel] [cast-iron] pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 28 05 44
SECTION 281300 - SECURITY MANAGEMENT SYSTEM

PART 1 - GENERAL

1.1 GENERAL

A. These specifications shall be utilized for the complete system as specified herein and as shown on the bid documents.

1.2 SCOPE OF WORK

A. Provide an expansion of the district wide Kantech Access Control System. District Wide Security Management System (SMS) which fully integrates all the functions and features specified herein for door access control and intrusion alarm and badge creation.

B. The scope includes all hardware, software, training and services required to provide a fully operational system, programmed to the Owner’s requirements and containing all software and licenses required to perform the specified functions.

1. Programming shall be sub-contracted to Milesahead Technologies who currently maintains the district wide Milestone/Kantech. Contact Tadd Dieringer, 937-630-3256 direct I mobile, 937-630-3231 fax, tadd.dieringer@milesaheadtechnology.com

C. These specifications contained herein describe specific functional requirements of the SMS as required by the Owner. It is the intent of these specifications to detail and describe the performance of the system. The system features outlined in the specifications are deemed mandatory for the project. References to model numbers are intended only for descriptive purposes. Systems that deviate from these Performance Specifications shall be considered alternate systems.

1.3 SYSTEM DESCRIPTION

A. The SMS shall provide for graphical based control and monitoring of local door access, elevator access and intrusion alarm within each building and centralized, graphical based control and monitoring through the district LAN/WAN. The SMS shall also provide software integration with the digital CCTV system. The SMS shall consist of four basic modules:

1. The Communications and database server module. The Kantech and Victor servers are existing and will be expanded with software, licenses and programming as required for this branch.

2. Door access control module (ACM).

a. The ACM shall control access and provide positional status at exterior doors and all controlled doors through the use of proximity cards, proximity card readers and door sensors.

b. The ACM shall interface with the electronic door hardware to provide lock/unlock signaling based upon valid card reads, schedules, real time control from user workstation or remote pushbuttons, and programming.
c. The ACM shall consist of Request to Exit devices where shown on the drawings or as required by system operation. These devices shall consist of either motion detectors or contacts in panic hardware and shall provide alarm free exit of card reader doors without the need to de-activate the alarm system.

d. The ACM shall provide interface with handicap door operators at access control doors to prevent activation of door opener if door is in locked position. Additional interface may be required for free egress to unlock doors when the Request-To-Exit handicap opener is pressed.

e. The ACM shall interface with the elevator controllers to provide lock-out of floors/elevators based upon card holder privileges for card readers. Card readers will be installed in elevator cabs or elevator lobby as indicated on drawings.

f. Where a building is provided with a handicap operators on interior and exterior main doors. The General trades package will supply the operators and pushbuttons (1 exterior, 2 vestibules, 1 interior) with low voltage wiring whips left above accessible ceiling. The electrical Contractor will make all required 120V connections. The security contractor will be responsible for making all low voltage wiring connections from the handicap opener, handicap push buttons, door hardware electrified hinge (electronic latch retraction and RX switch in panic hardware), magnetic door contact switch (provided under the security scope), door hardware power supply and the SMS system door control panels for a fully functional entry. The security contractor is to coordinate the proper operation, interlocking, timing and sequencing of doors and door operators with door hardware supplier.

g. The ACM shall also provide door position annunciation for all exterior doors and through all card reader controlled doors through the use of flush frame door contacts. Real time door position annunciation shall be provided by the remote software.

h. The ACM shall provide TOD schedule and real-time control of all exterior doors equipped with Magnetic locking devices. In addition, The ACM shall integrate with the building fire alarm system to provide code required release of mag lock doors under fire alarm conditions.

i. The ACM shall provide interface and controls of electromagnetic door hold opens to close doors on TOD schedules and on Panic/duress situations. Where hold open doors are connected to the FA system, the ACM shall signal the FA system to release the associated doors.

j. Panic/Duress – The ACM shall provide for immediate TOD schedule override on all access doors under panic/duress alarm. In addition, the ACM shall provide immediate override of card holder privileges and restrict valid card reads to a select group of users during panic/duress alarm. ACM shall also interface with fire alarm system to drop ALL door hold opens under panic/duress alarm.

k. The ACM control software must provide a graphical floor plan of the finished building with real time interactive annunciation and control of monitored and controlled doors. The graphical floor plan shall be entered and configured as part of
this contract. User interface shall provide visual indication of door position status and hot links at each door on the floor plan drawing.

l. This module shall contain remote access and control software installed on individual building workstations as directed by the Owner. These workstations, through the LAN connection, shall be able to perform access, control, monitoring and programming features. The software shall be provided with all required licensing and password protected.

m. The ACM shall provide for any combination of real time and calendar based, Time Of Day operation for all controlled doors.

3. Alarm management module (AMM)

a. The AMM shall provide for the control and annunciation of alarm conditions. The module shall accept inputs from the door access module, remote devices such as motion detectors and keypads and from other systems such as fire alarm and CCTV. The module shall include alarm reporting to off-site services, event logging with printouts and annunciation through audible devices.

b. The AMM shall consist of the hardware and software required to generate multiple alarm zones within each building. Each zone shall be capable of independently controlling input and out devices programmed to that zone regardless of physical location within the building. The system shall be able to control up to sixteen (16) alarm zones per building. Selection of alarm zones and grouping of corresponding devices shall be coordinated with Owner.

c. The AMM shall consist of door contacts for perimeter protection, and motion detectors for interior protection. The AMM shall utilize system keypads for arm/disarm locally of building intrusion alarms. The keypads shall be capable of controlling multiple zones based upon user codes. The system shall provide for the ability to assign unique arm/disarm codes to staff with codes granting user definable access to the various zones within a building.

d. The AMM shall consist of Request to Exit devices where shown on the drawings or as required by system operation. These devices shall consist of either motion detectors or contacts in panic hardware and shall provide alarm free exit of monitored doors without the need to de-activate the alarm system.

e. The AMM shall include all software programming features required to generate multiple schedules for the automatic arming and disarming of zones and individual devices. The AMM shall interface with the door position sensors and be capable of supporting temporary deactivation of door sensors upon valid card reads or “REX” devices.

f. The AMM must provide a graphical floor plan of the finished building with real time interactive annunciation and control of alarm points. The graphical floor plan shall be entered and configured as part of this contract. User interface shall provide visual indication of alarm point status and hot links at each alarm point on the floor plan drawing.
g. The AMM must provide a graphical interface on the building workstation showing real time alarm activity in the form of a scrolling alarm log screen. Alarms shall be fully customizable with name, location, directions, and priority level. The Alarm log shall provide users the ability to acknowledge and silence alarms as well as logging required responses to alarm events. Alarms shall include the following at a minimum:

1) Motion Detectors and door contacts activated after system is “armed”

2) Access Control Door alarms such as door forced, invalid card read

3) Propped door alarm with user definable interval for length of time open prior to generating alarm.

4) System hardware failure

5) Loss of network connection

h. The AMM shall provide for calendar based, Time Of Day operation for all alarm monitoring devices and security zones.

i. The AMM shall include a digital dialer panel with cellular back-up. The alarm management module shall consist of a 3 year service contract with an UL listed off-site monitoring company (Hamilton currently utilizes ADT). Monitoring company shall be available from a local or toll-free telephone number. Service contract shall be included in the bid price but shall be as selected by the Owner.

j. Provide a contact closure signal to the Central Sound System, installed by others, for alarm activation. The contact closure shall be programmed to operate during the pre-alarm delay. The SMS contractor shall provide all required hardware and wiring to the Central Sound System and assist the CSS Contractor in providing a unique building wide all call chime to sound for the duration of the pre-alarm state. Once the alarm has been activated, the chime shall be discontinued.

4. Graphical User Interface Module

a. Each user workstation shall have the ability to provide graphical based, real time alarm management, access control monitoring, door position monitoring and CCTV live/recorded video viewing.

b. Alarm management shall provide for both graphical building floor plans with interactive user icons for all alarm points, and an alarm log screen.

c. Electronic door management shall provide for both a menu tree structure listing all available controlled doors installed throughout the district and a graphical building floor plan for all buildings with user interactive icons for all controlled doors allowing real time control of door lock/unlock status.

d. Video management shall provide for both a menu tree structure listing all available video cameras installed throughout the district and a graphical building floor plan.
for all buildings with user interactive icons for all cameras allowing instant access to live video.

e. The graphical user interface shall be provided with content restrictions based upon user log-in and authorization levels. Typical restrictions would include the ability to prevent users from making system programming changes, viewing certain cameras, unlocking specified doors, etc.

B. The Contractor shall be responsible for developing and programming a total system sequence of operation for the system to include at a minimum:

1. Input of all staff personal records into the card holder database (20 staff with door privileges)

2. Creation of door access groups for all buildings. Assigning door access groups to access card holders.

3. Creation of alarm codes for all staff including building and zone privileges for each code.

4. Creation of multiple Time Of Day schedules for all controlled doors, alarm devices and security zones to account for various modes of operation (normal, holiday, snow day, in-service day, etc.) in each building.

C. Alarm dialer codes and telephone numbers to communicate with Central Station.

1.4 QUALITY ASSURANCE

A. All system components shall be UL listed.

B. Installation shall be in compliance with the National Electric Code and all other applicable codes. The system shall be in compliance with all FCC Rules and Regulations.

C. All equipment described herein shall be the product of a manufacturer of established reputation and experience, who shall have produced similar equipment for a period of at least 2 years and who shall be able to refer to similar installations within a 75 mile radius now rendering satisfactory service.

D. The manufacturer and their local agent shall show satisfactory evidence upon request that they maintain a fully equipped service center capable of furnishing adequate inspection and service to the equipment including standard replacement parts. The manufacturer and /or agent shall be prepared to offer a service contract for the maintenance of the system after the warranty period.

E. To establish continuity in the manufacturer, systems components shall be the standard product of one manufacturer. Further, an effort shall be made to establish common sources for equipment of all systems. The manufacturer will have a minimum of five (5) years’ experience in the manufacture of progressive products specified.

F. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.
1.5 CONTRACTOR QUALIFICATIONS

A. The Security Management System shall be furnished, installed and programmed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the SMS contractor to utilize a sub-contractor for any portion of the work, unless the sub-contractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.

B. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.

C. The Contractor shall employ factory trained service personnel for the service and maintenance of the system.

D. The Contractor shall have had a minimum of 1 year experience with the specified SMS. This experience shall include having completed a minimum of 2 installations in the past 24 months of similar size and scope. The Contractor shall provide references and contact information for the project sites in which the qualifying installations occurred.

1.6 SHOP DRAWINGS – THE SUBMITTALS SHALL CONSIST OF THE FOLLOWING INFORMATION:

A. Job specific system block diagram indicating the actual hardware required for the project including part numbers and interconnecting wiring requirements.

B. Details of interconnection with CCTV system.

C. Complete and comprehensive Equipment Catalog Specification Sheets of each component provided, job specific.

D. 30x42 floor plans at a scale of not less than 1/8 inches=1 feet-0 inches showing location of all items of equipment. Drawings shall also indicate each location where 120 power is required.

E. Scale elevation of all racks including configuration of equipment within racks and interconnection diagrams.

F. Software Data: The data package shall consist of descriptions of the operation and capability of system and application software as specified. This shall also include licensing information where applicable.

G. Submittals that do not contain all the above information will be rejected.

1.7 RELATED WORK BY OTHERS

A. The door hardware and associated power supplies are being provided under the General trades Contract. The electrical branch circuitry, conduit and box rough-ins are being provided under the Electrical trades package.

PART 2 - PRODUCTS
2.1 GENERAL

A. The main control panel and all door control panels shall be backed up by internal batteries or provided with UPS units as required to provide a minimum of 1 hour operation upon loss of building power. Refer to additional requirements for back-up of SMS server PC.

B. All systems shall be configured for WAN access, multiple buildings, multiple sites, and licensed for all required features and functions. The use of the term “be capable of” shall require that the system be provided with all required hardware, software and licenses to accomplish the feature/function being referenced.

2.2 COMMUNICATIONS, DATABASE AND CONTROL SERVER

A. All software, firmware and licenses upgrades to the existing Kantech/Victor servers required to support this installation shall be included.

B. Provide the Owner with a PC Workstation. The workstations shall have the following minimum requirements / capabilities.

1. CPU – Minimum 2.8GHz dual core.
2. Memory – Minimum 8GB triple channel.
3. Main HDD (for operating system and system software) - Minimum 80GB, 7200RPM, ATA133 Hard drive.
4. Recording HDD (for local video recording) – Minimum 500GB, 7200RPM, serial ATA.
5. Video Card – 2GB Video card, quad display digital video.
6. Removable Media – DVD-RW +/- (16x double layer), 1.44Mb floppy disk.
7. Network Interface - 100/1000 switched Ethernet Card.
8. User Interface – Two (2) 17” XGA flat panel LCD color monitor, 101 Key Microsoft keyboard and optical 3-button USB mouse with scroll wheel.
9. ATX Mid-Tower case with minimum 450W power supply, 1.44Mb floppy drive, and hot swappable drive bay.
10. Windows 7 Professional 64bit. Coordinate exact OS as required by owner and software requirements.
11. Microsoft Internet Explorer as currently available.
12. PC to be turned over to owner for installation. PC will be connected to local data drop. Coordinate network architecture with owner to verify proper VLAN configuration of data port serving NVC.
13. Workstation shall be fully functional with all required software and drivers including software for digital CCTV system. Turn over copy of software to Owner.
14. Manufacturers - The following list of manufacturers are considered approved for use provided the individual selections conform at a minimum to the above listed specifications: HP, Dell, Gateway, eMachines, Acer

C. Workstation shall be fully functional with all required software and drivers including software for digital CCTV system and remote access. Turn over copy of remote access software to Owner.

D. Each PC administration workstation shall be backed up by a UPS unit providing a minimum of 20 minutes of battery time. The UPS shall be floor mounted and shall meet or exceed the following specifications:
   1. Communications – Unit shall communicate through the LAN to provide remote diagnostics and alarm conditions.
   2. Input voltage range (92V – 142V)
   3. Input frequency range (50/60 Hz ± 3 Hz) (auto sensing)
   4. Batteries
      a. Maintenance free sealed lead acid
      b. Hot swappable
      c. Intelligent battery management
      d. Surge protection – 480 joules
      e. Filtering – UL 1449
      f. UL listed
   5. Output - Minimum of six (6) NEMA 5-15R receptacles switched and conditioned.
   6. Input - 10 foot line cord with 20A plug.
   7. The contractor shall be responsible for sizing of UPS units and any required battery modules to provide the total required battery time based upon the quantity and type of workstation utilized to provide 20 minutes of standby operation.
   8. Unit as manufactured by APC, Liebert or Tripp Lite.

2.3 ACCESS CONTROL MODULE

A. Door Control Panel(s) shall consist of network communications via Ethernet based IP loop and shall contain all electronics and on-board memory to provide door access and interface with card readers, door position sensors, electronic door hardware, auxiliary I/O points, and the local fire alarm system in the event of loss of server communications. The panel(s) shall provide access control, alarm monitoring, and time zone control for both access and egress of selected areas. The panel shall have the capability for system expansion.
B. Proximity Readers – Provide proximity readers as indicated on plans. Readers shall either mount to gang wall box or to door mullion as indicated on drawings. Readers shall utilize either standard proximity effect or include a secondary keypad for additional authentication. Refer to drawings for reader types and locations.

C. Door position sensors – Recessed mounted DPDT door magnetic switch contacts to function as door position sensors and alarm points. Refer to drawings for locations. Utilize sensors to provide door position status during occupied hours as required by Owner’s programming and alarm points when so programmed or required by the Owner’s sequence of operation.

D. Electronic door hardware – Provide low voltage power and controls to electronic door hardware to remotely lock/unlock selected doors in real time via the software GUI, through local card readers, through TOD schedules, interface with intercom system, or remote push button devices. System shall provide the Owner with the ability to remotely control doors from the remote access workstations, head end server, associated proximity readers, request-to-exit devices, intercom system and the fire alarm system. Electronic door hardware are supplied by the General Trades Contract with wiring pig tails. Electronic hardware is being installed in the door frames by others. This contract shall be responsible for all low voltage power, low voltage wiring from door hardware and power supplies to the access control system for a complete, functional and operating system.

E. Handicap Operator Doors

1. Provide hardware, software, programming and wiring to interface door control with handicap operators at doors with access control. Interface to prevent activation of door opener when door is in locked state.

2. Each building is provided with a handicap operators as indicated on plans.

3. The General trades package will supply the operators and pushbuttons (1 exterior, 2 vestibules, 1 interior) with low voltage wiring whips. The electrical Contractor will make all required 120V connections. The security contractor will be responsible for making all low voltage wiring connections from the handicap opener, handicap push buttons, door hardware electrified hinge (electronic latch retraction and RX switch in panic hardware), magnetic door contact switch (provided under the security scope), door hardware power supply and the SMS system door control panels for a fully functional entry.

4. The security contractor is to coordinate the proper operation, interlocking, timing and sequencing of doors and door operators with door hardware supplier. The interface shall be wired and programmed such that egress side push buttons can open the doors even upon failure of the SMS system.

F. Provide push button/switch units as indicated on plans to provide remote unlock of selected access control doors.

G. Request to Exit Devices – Provide REX devices such as motion detectors or contacts in push bar panic hardware to provide alarm free exit of monitored doors during system operation. REX devices shall be installed, powered, wired and programmed as part of this contract.

H. Provide battery back-up for door control panels to provide 1 hour operation.
I. Contractor shall include all necessary wire, cable and accessories for a complete working system.

2.4 ALARM MANAGEMENT MODULE

A. Alarm monitoring panel(s) shall consist of Ethernet communications to local client workstation PC and shall contain all electronics and on-board memory to provide alarm monitoring and interface with keypads, door position sensors, electronic door hardware and the alarm dialer. The panel(s) shall provide alarm monitoring and time zone control for all protected areas.

1. Each building shall be provided with zone controls as coordinated with Owner. Individual sensing devices shall be assignable per zone through software and shall not require system re-wiring.

B. Motion Detectors – Ceiling mounted, passive infra-red with 360 deg. Coverage. Provide and install motion detectors as shown on the drawings. Motion detectors shall be controlled by zone or room, so that and individual area may be turned on or off without effecting the other areas. Provide ¾ inch plywood mounted above ceiling tile containing motion sensor to minimize false alarms due to vibration.

C. Motion detectors - Wall mount, passive infra-red with coverage patterns and masking as required. Provide and install motion detectors as shown on the drawings. Motion detectors shall be controlled by zone or room, so that and individual area may be turned on or off without effecting the other areas.

D. Door position sensors – Utilize door position sensors to activate alarms as required by Owner’s programming requirements.

E. Monitoring and annunciation – Provide control panel and telephone system dialer to provide off-site monitoring through a UL listed Central Station Service. Provide power and signaling to exterior, weatherproof horn, roof mounted for local alarm annunciation. Provide interconnection with building paging system to activate alarm tones within the building. Panel shall be provided with integral battery back-up.

F. Provide power and signaling to exterior, weatherproof horn, roof mounted for local alarm annunciation. Provide interconnection with building paging system to activate alarm tones within the building. Panel shall be provided with integral battery back-up.

G. Provide battery back-up for alarm panels to provide 4 hours active (sounding alarm and activating dialer) and 24 hours standby (monitor mode only).

H. Contractor shall include all necessary wire, cable and accessories for a complete working system.

2.5 MOBILITY MODULE

A. The SMS platform shall include a mobility server with all applicable apps to deliver user interface and control to various mobile platforms including iOS and Android mobile devices.
2.6 EXTERIOR GATE ALARM

A. Exterior Terrace gate is being provided with a position switch by others.

B. Provide a door alarm/monitoring station as located on the drawings which provides audible and visual annunciation of the gate position and key-switch override.

C. Provide required cabling, power supplies and annunciation unit. Kouba system LDA9602 or equivalent.

2.7 CABLE MANAGEMENT SYSTEM

A. Provide pre-manufactured cable supports. Cable supports shall be secured to building structure through threaded rod, beam clamps or other UL approved supports as required by site conditions. Components shall provide a minimum cable support point spacing of 48 inches.

B. Cable management devices must be sized to accommodate 100 percent spare capacity of the final installed cable base.

C. Cable management system shall be secured to building structure utilizing manufactured approved methods and hardware.

D. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building’s structure such as beams, joists, etc. to hang cable from will not be acceptable.

E. Bridle rings shall not be acceptable.

F. Manufactured by Caddy, Mineralac or B-Line.

G. Contractor shall include all necessary wire, cable and accessories for a complete working system.

PART 3 - INSTALLATION

3.1 GENERAL INSTALLATION

A. Install systems in accordance with UL, NEC and all other applicable codes. Install system to comply with drawings and final shop drawings in compliance with manufacturer instructions. Provide all required hardware and labor for rack mounting of head-end system components.

B. Refer to plans for locations and quantities of equipment. Equipment locations shown on plans will be required to be field coordinated to ensure proper system operation.

C. No items of equipment shall be installed in such a manner as to void or reduce the proper operating characteristics of individual components or of the system. Devices such as motion detectors, audio detectors, glass break sensors, etc. shall be installed following the manufacturer’s recommendations.
D. Perform all work under the on-site supervision of a factory authorized trained technician. It shall be the responsibility of the technician to check, inspect and adjust this installation to the engineer’s and Owner approval. A CSR of the installing contractor or manufacturer shall train the Owner’s personnel on the proper operation and maintenance of the equipment. Perform all work in conjunction with this installation in accordance with good engineering practices as established by NEC.

3.2 WIRING INSTALLATION

A. All wiring between devices shall be run open wired above accessible ceilings. Where existing cable management systems are in place and there is adequate capacity to install the SMS wiring, the contractor may utilize these pathways providing they have coordinated with all other wiring contractor on site.

B. Where pathways do not exist for SMS wiring, this contract shall be responsible for providing all required cable management systems such as sleeves, conduits, J-hooks, etc. to support communications cabling to meet building codes and manufacturer’s recommendations.

C. All cabling installed in ceiling spaces that are used for air distribution plenums shall be UL plenum rated.

D. This contract shall be responsible for furnishing and installing all required cabling between components to form a complete and operational system meeting all the requirements of this specifications.

E. The SMS contractor shall be responsible for interconnection and signaling including all wiring and terminations at both ends for the following auxiliary systems

1. Fire Alarm – for control of doors during fire alarm, and for release of door hold opens connected directly to the FA system

3.3 TELECOMMUNICATIONS ROOMS

A. The lay-out of the telecommunications rooms as depicted on the drawings shall be utilized as a general guide for bidding purposes. The final room layout shall be carefully coordinated with input from the Owner and from other trades with equipment and/or cabinets to be placed in the room. Final configuration of telecom rooms shall be submitted to Engineer as a coordination drawing with information from all other trades occupying the same room for review prior to permanent mounting of equipment or termination of cabling.

B. Coordinate lay-out of telecom rooms to avoid placing telecommunications equipment and cabinets under water piping (other than sprinkler heads) or HVAC units.

C. Coordinate lay-out of telecom rooms with electrical plans and locations of electrical outlets.

D. Lay-out of telecommunications equipment cabinets and racks shall provide a minimum of 36 inch isle in front and behind equipment racks and cabinets which is clear of obstructions or equipment protrusions.
E. Coordinate rack locations and orientation to maintain required clearances including any equipment depths that may have to be accounted for. Some equipment, such as UPS units may have special mounting requirements that need additional coordination.

3.4 GROUNDING

A. The installing contractor shall be responsible for ensuring the grounding integrity of all installed equipment to eliminate the potential for equipment or personnel hazards due to improperly or inadequately grounded systems.

B. All grounding and bonding shall be in conformance with the National Electric Code, article 250 and as recommended by EIA/TIA-607.

C. The Division 26 Contractor has provided 120V branch circuitry for use by the SMS system contractor. The branch circuitry is run with a dedicated equipment grounding conductor which shall be utilized by the SMS system equipment. In no case shall the SMS system installation compromise the integrity of the Building Electrical Grounding System.

3.5 PROGRAMMING

A. It is the Contractor’s responsibility to program the system in this section according to the Owner’s wishes. This involves day and night restrictions, time schedules, building zoning, access control schedules, sequence of operation, etc.

B. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming. This programming agreement shall then be written out in detail and forwarded to the Engineer for approval.

C. After approval is granted, proceed with final programming. The programming shall include the following at a minimum:

1. Input of all staff personal records into the card holder database
2. Creation of door groups. Assigning door and elevator access groups to access card holders.
3. Creation of alarm codes in all buildings for all staff including building and zone privileges for each code.
4. Creation of multiple Time Of Day schedules for all controlled doors, alarm devices and security zones to account for various modes of operation (normal, holiday, snow day, in-service day, etc.) in all buildings.
5. Creation of security zones within each building including assigning associated alarm devices to respective zones and creation of arm/disarm codes for each zone.
6. Software interface with FA system for release of door hold opens and for release of door locks on fire alarm

D. Alarm dialer codes and numbers to communicate with Central Station.
3.6 IDENTIFICATION/LABELING

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.

B. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.7 TESTING

A. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all site testing. The Owner will witness all performance verification. Original copies of all data produced during performance verification shall be turned over to the Owner at the conclusion of testing prior to final approval.

B. The field testing shall as a minimum include:

1. Verification that alarm points are received, annunciated properly and transmitted through the central monitoring station.

2. Verification that all motion detectors have the proper coverage patterns and that false alarms are not being generated due to motion coverage patterns into adjacent areas.

3. Verification that all user input and control features are accessible at each keypad and operators control station.

4. Verification that the final system programming including schedules and sequence of operation are performing as expected.

5. Verification that access control features including door control and door position sensing are operating properly and as required by the Owner and as established during the programming phase.

C. The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Owner that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure.

D. Performance Verification Test: The Contractor shall demonstrate that the completed SMS complies with the contract requirements. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown. The performance verification test, as specified, shall not be started until receipt by the Contractor of written permission from the Owner, based on the Contractor's written report. This shall include certification of successful completion of Contractor Field Testing as specified in paragraph "Contractor's Field Testing," and upon successful completion of training as specified. The Owner may terminate testing at any time when the system fails to perform as specified.

3.8 SYSTEM START-UP REQUIREMENTS
A. The equipment supplier shall provide system integration, set-up and start-up assistance to the Installing Contractor. The proposal shall include complete technical on-site assistance for these activities as required for this system’s size and complexity. After completion of the installation, the supplier shall commission the system and request an initial acceptance test by the Owner and Engineer. A final acceptance test shall then be scheduled after correcting any system deficiencies or functionality issues that are determined in the initial test. Provide training, by a system certified trainer, at the project site as coordinated with the Owner and Engineer. The training shall include the following elements:

1. Start-up shall include a complete working demonstration of the SMS.
2. Demonstrate purpose, adjustment, operation and maintenance of the system including each component and control.
3. Review binder containing instructions and equipment and systems data.
4. Technical training sessions, which shall include hands-on training, accompanied by full system documentation and system as-built drawings.
5. Training shall include any documentation and hands-on exercises necessary to enable operations personnel to assume full operating responsibility for the SMS after completion of the training period.
6. Provide a manufacturer’s “Certificate of Completion” that is signed, dated and documented for each trainee.
7. The SMS manufacturer shall have available technical support for the Owner.

B. Division 28 Contractor shall have the total single point of contact responsibility for all aspects of the SMS implementation, including equipment supply, integration, customization, start-up and on-going systems support.

C. Division 28 Contractor shall employ a service technician to the Cincinnati/Hamilton area that is specially trained and certified to modify and repair the SMS system and who specializes in SMS and Security system integration.

3.9 TRAINING REQUIREMENTS

A. Provide the Owner with a minimum of 4 hours of training for each building and an additional 24 hours of training for District NOC personnel designed to make all users familiar with the full and complete operation of the system. All training shall be executed by factory trained and certified personnel. Provide documentation of qualifications prior to training.

B. The training periods shall be scheduled with the Owner after the successful completion of the system. Training on a demonstration system will not be accepted.

C. Training shall be provided to cover three general classes of users

1. Monitoring/control only end user – This user should be able to access the system for monitoring and control of local equipment only. Provide this level at each building.
2. Local Administrator end user – This user should be able to perform all functions of the monitoring/control end user and be able to perform local programming features such as TOD schedule changes. Provide this level at each building.

3. District Administrator end user – This user should be able to perform all functions of the Local Administrator end user and be able to perform all global programming, maintenance, reporting, database management, etc. to be fully capable of managing all aspects of system operation. Provide this level at the NOC only.

D. Provide all training and utilize specified manuals and record documentation. All training shall be provided at the project site and coordinated with the Owner.

E. Training shall include multiple four-hour sessions encompassing all instructions required for system operation. Provide operators manuals and user guides with training. Provide follow up training after initial training.

F. Training shall utilize the equipment provided at the project site. Coordinate use, time and availability of equipment with the Owner.

G. Demonstrate adjustment, operation and maintenance of the system including each component and control.

H. Contractor shall provide a follow-up site inspection / training refresher to the Owner 1 month, 3 months and 6 months after final acceptance to verify system is operating correctly within programmed parameters and to review operational and training with Owner personnel.

I. All training shall be video-taped and stored in digital format for the Owner’s future use. Contractor responsible for providing required video recording and digital encoding equipment.

3.10 SYSTEM ACCEPTANCE REQUIREMENTS

A. The contractor shall demonstrate proper operation of all aspects of the system to the Owner’s representative.

3.11 WARRANTY

A. Warrant all workmanship, equipment, material and software entering into this contract for a period of three (3) years from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Provide a statement of this warranty with the O & M Manuals.

B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period. Provide estimated cost of this service contract within the proposal.

C. Contractor shall be responsible to provide service during normal working hours within (8) hours after notification by the Owner for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of any system component inhibiting access to the system operation, or the loss of the main server.
D. If equipment cannot be repaired with 24 hours of service visit, the Contractor shall provide “loaner” equipment to the Owner at no charge.

E. Proper identification is required and must be visible while on-site for warranty/service calls. Provide notification of completion to the Owner prior to departing the site.

3.12 O&M MANUALS

A. Copies of all approved shop drawings with the Engineer’s stamp.

B. Owner’s manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner’s manuals. CDs containing electronic versions of Owner’s manuals must contain the proper software viewers for each document type.

C. Technology drawings updated with final as-Built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.

D. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

E. Rack elevations for all systems with rack mounted equipment.

F. System Operating Instructions: Provide a clear and concise description of operation which gives, in detail, the information required to properly operate the equipment and system.

G. Warranty: Provide statement of warranty with O&M manuals.

END OF SECTION 281300
1.1 GENERAL

A. These specifications shall be utilized for the complete system as specified herein and as shown on the bid documents.

1.2 SCOPE OF WORK

A. Provide a Security System which fully integrates all the functions and features specified herein for intrusion alarm. The Security system shall be an expansion of the current district wide DSC solution with dedicated alarm panels and IP interface in each building.

B. The security system shall be an electronically operated, supervised system of modular design utilizing addressable technology for remote devices. System includes control panel, door contacts, break glass sensors, keypads, power supplies and batteries, phone line dialer, supervised wiring, etc. as required for a complete and operational system.

C. The security system shall fully integrate with the existing Kantech/Victor implementation within the district and with new equipment within this branch.

D. The scope includes all hardware, software, training and services required to provide a fully operational system, programmed to the Owner’s requirements and containing all software and licenses required to perform the specified functions.

1.3 SYSTEM DESCRIPTION

A. Operation of any addressable perimeter protection device shall initiate the following:

1. Display alarm condition on LCD keypad display.
2. Provide audible annunciation via indoor/outdoor master siren.
3. Arm/disarm specific zones/partitions from any system keypad.
4. Transmit a signal over supervised telephone lines to a central station or security monitor service as coordinated with Owner via a digital dialer.

1.4 QUALITY ASSURANCE

A. All system components shall be UL listed.

B. Installation shall be in compliance with the National Electric Code and all other applicable codes. The system shall be in compliance with all FCC Rules and Regulations.

C. All equipment described herein shall be the product of a manufacturer of established reputation and experience, who shall have produced similar equipment for a period of at least 2 years and who shall be able to refer to similar installations within a 75 mile radius now rendering satisfactory service.

D. The manufacturer and their local agent shall show satisfactory evidence upon request that they maintain a fully equipped service center capable of furnishing adequate inspection and service
to the equipment including standard replacement parts. The manufacturer and/or agent shall be prepared to offer a service contract for the maintenance of the system after the warranty period.

E. To establish continuity in the manufacturer, systems components shall be the standard product of one manufacturer. Further, an effort shall be made to establish common sources for equipment of all systems. The manufacturer will have a minimum of five (5) years’ experience in the manufacture of progressive products specified.

F. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.

1.5 CONTRACTOR QUALIFICATIONS

A. The Security Management System shall be furnished, installed and programmed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the SMS contractor to utilize a sub-contractor for any portion of the work, unless the sub-contractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.

B. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.

C. The Contractor shall employ factory trained service personnel for the service and maintenance of the system.

D. The Contractor shall have had a minimum of 1 year experience with the specified SMS. This experience shall include having completed a minimum of 2 installations in the past 12 months of similar size and scope. The Contractor shall provide references and contact information for the project sites in which the qualifying installations occurred.

1.6 SHOP DRAWINGS – THE SUBMITTALS SHALL CONSIST OF THE FOLLOWING INFORMATION:

A. Job specific system block diagram indicating the actual hardware required for the project including part numbers and interconnecting wiring requirements.

B. Complete and comprehensive Equipment Catalog Specification Sheets of each component provided, job specific.

C. 30x42 floor plans at a scale of not less than 1/8 inch=1 foot-0 inches showing location of all items of equipment. Drawings shall also indicate each location where 120 power is required.

D. Software Data: The data package shall consist of descriptions of the operation and capability of system and application software as specified. This shall also include licensing information where applicable.

E. Submittals that do not contain all the above information will be rejected.

PART 2 - PRODUCTS
2.1 PRODUCT EQUIVALENCY

A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor’s expense.

B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

2.2 GENERAL

A. This specification is intended to establish a carefully planned minimum level of quality and performance for all components, and will be rigorously enforced by Owner. Acceptable manufacturers of components described herein are

   1. DSC

B. These manufacturers will be approved as equals if all specified features are provided. Other manufacturers must submit literature with all system features listed at least 15 days prior to the bid due date to be considered. Other manufacturers will be approved in writing prior to bid if equipment submitted is acceptable. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications.

C. The security system shall be a regularly manufactured system offered by a single manufacturer/source as an integrated system.

D. The main control panel and all door control panels shall be backed up by internal batteries or provided with UPS units as required to provide a minimum of 1 hour operation upon loss of building power. Refer to additional requirements for back-up of SMS server PC.

2.3 CONTROL UNIT

A. Control unit shall contain all necessary components to provide complete control, testing and indicating facilities for the entire security alarm system.

B. Control unit shall support 16 hardwire zones, 8 partitions and 112 addressable devices.

C. Alarm monitoring panel(s) shall consist of network communications via RS-485 or RS-232 loop and shall contain all electronics and on-board memory to provide alarm monitoring and interface with keypads, door position sensors, electronic door hardware and the alarm dialer. The panel(s) shall provide alarm monitoring and time zone control for all protected areas.

D. The system shall support 1000 user codes with 64 different access levels.

E. Provide the DSC IP-Link interface along with all required programming to provide remote system viewing/annunciation/management.
F. Provide auxiliary power supply with battery and battery charger. Battery shall be sized to provide system operation for a period of 8 hours and system trouble annunciation for a period of 24 hours.

2.4 PERIMETER PROTECTION DEVICES

A. Door Contacts - Flush door frame mounted, 2-piece, magnetic switch. DPDT with color to match door frame.
   1. Devices shall be installed and wired prior to grouting of door frames.

B. Break Glass Sensors – Surface mounted addressable detector to utilize DSP analyses technology, selectable sensitivity range, test switch and transient protection utilizing MOVs.. Recess ceiling mounted, audio and shock sensors.
   2. Provide the Owner with a glass break tester.

2.5 MOTION DETECTORS

A. Ceiling mounted PIR – 360 deg., ceiling mount addressable detector with quad element low noise PIR and fresnel lens, high level static protection, tamper switch, field adjustable detection modes.

B. Wall mounted PIR – Multi-level PIR with two (2) independent, dual element low noise sensors, High level static protection, tamper switch.

C. Wall mounted Dual technology – Multi-level PIR and digital microwave signal processing, high level static protection, tamper switch, adjustable microwave detection pattern, automatic temperature compensation, addressable module.

2.6 AUDIO MONITORING DEVICE

A. Provide audio sensing devices tied in to the system alarm and monitoring panel to provide real time audio monitoring of the area via the alarm panel at the Central Station.

2.7 Keypads – 32 character, LCD display with adjustable brightness and contrast, backlit display and keys, piezo buzzer. Keypad shall be able to access all zones and partitions within the system. Keypads shall be capable of performing all user operations and system programming.

2.8 Remote Annunciator – 32 point capacity with color LED, customizable graphical overlays, combination red, green and yellow LED and power modules.

2.9 ANNUNCIATION

A. Exterior – Provide wall mounted RED LED high power strobe powered from the main control panel.

2.10 Contractor shall include all necessary wire, cable and accessories for a complete working system.
PART 3 - INSTALLATION

3.1 GENERAL INSTALLATION

A. Install systems in accordance with UL, NEC and all other applicable codes. Install system to comply with drawings and final shop drawings in compliance with manufacturer instructions. Provide all required hardware and labor for rack mounting of head-end system components.

B. 120V power for control panels, remote power panels, remote input/output panels, etc. shall be provided under this specification section as coordinated with the Electrical Contractor.

C. Refer to plans for locations and quantities of equipment. Equipment locations shown on plans will be required to be field coordinated to ensure proper system operation.

D. No items of equipment shall be installed in such a manner as to void or reduce the proper operating characteristics of individual components or of the system. Devices such as motion detectors, audio detectors, glass break sensors, etc. shall be installed following the manufacturer’s recommendations.

E. Perform all work under the on-site supervision of a factory authorized trained technician. It shall be the responsibility of the technician to check, inspect and adjust this installation to the engineer’s and Owner approval. A CSR of the installing contractor or manufacturer shall train the Owner’s personnel on the proper operation and maintenance of the equipment. Perform all work in conjunction with this installation in accordance with good engineering practices as established by NEC.

3.2 WIRING INSTALLATION

A. All wiring between devices shall be run open wired above accessible ceilings. Where existing cable management systems are in place and there is adequate capacity to install the wiring, the contractor may utilize these pathways providing they have coordinated with all other wiring contractor on site.

B. Where pathways do not exist for wiring, this contract shall be responsible for providing all required cable management systems such as J-hooks to support communications cabling to meet building codes and manufacturer’s recommendations.

C. All cabling installed in ceiling spaces that are used for air distribution plenums shall be UL plenum rated.

D. This contract shall be responsible for furnishing and installing all required cabling between components to form a complete and operational system meeting all the requirements of this specifications.

3.3 GROUNDING

A. The installing contractor shall be responsible for ensuring the grounding integrity of all installed equipment to eliminate the potential for equipment or personnel hazards due to improperly or inadequately grounded systems.
B. All grounding and bonding shall be in conformance with the National Electric Code, article 250 and as recommended by EIA/TIA-607.

C. The Division 16 Contractor has provided 120V branch circuitry for use by the SMS system contractor. The branch circuitry is run with a dedicated equipment grounding conductor which shall be utilized by the SMS system equipment. In no case shall the SMS system installation compromise the integrity of the Building Electrical Grounding System.

3.4 PROGRAMMING

A. It is the Contractor’s responsibility to program the system in this section according to the Owner’s wishes. This involves day and night restrictions, time schedules, building zoning, sequence of operation, etc. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming. This programming agreement shall then be written out in detail and forwarded to the Engineer for approval. After approval is granted, proceed with final programming.

3.5 IDENTIFICATION/LABELING

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.

B. The contractor shall be responsible for generating and programming the labeling for camera information within the recorder software.

C. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.6 TESTING

A. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all site testing. The Owner will witness all performance verification. Original copies of all data produced during performance verification shall be turned over to the Owner at the conclusion of testing prior to final approval.

B. The field testing shall as a minimum include:

1. Verification that alarm points are received, annunciated properly and transmitted through the central monitoring station.
2. Verification that all motion detectors have the proper coverage patterns and that false alarms are not being generated due to motion coverage patterns into adjacent areas.
3. Verification that all user input and control features are accessible at each keypad and operators control station.
4. Verification that the final system programming including schedules and sequence of operation are performing as expected.

C. The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Owner that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure.
D. Performance Verification Test: The Contractor shall demonstrate that the completed SMS complies with the contract requirements. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown. The performance verification test, as specified, shall not be started until receipt by the Contractor of written permission from the Owner, based on the Contractor's written report. This shall include certification of successful completion of Contractor Field Testing as specified in paragraph "Contractor's Field Testing," and upon successful completion of training as specified. The Owner may terminate testing at any time when the system fails to perform as specified.

3.7 TRAINING REQUIREMENTS

A. Provide the Owner with a minimum of 8 hours of training designed to make all users familiar with the operation of the system.

B. Provide all training and utilize specified manuals and record documentation. All training shall be provided at the project site and coordinated with the Owner.

C. Training shall utilize the equipment provided at the project site. Coordinate use, time and availability of equipment with the Owner.

D. Demonstrate adjustment, operation and maintenance of the system including each component and control.

3.8 SYSTEM ACCEPTANCE REQUIREMENTS

A. The contractor shall demonstrate proper operation of all aspects of the system to the Owner’s representative.

3.9 AS-BUILT DOCUMENTATION

A. Component Operating Manual including technical data sheets.

B. Wiring diagrams/details:

3.10 Warrant all workmanship, equipment, material and software entering into this contract for a period of three (3) years from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Provide a statement of this warranty with the O & M Manuals.

END OF SECTION 281600
PART 1 - GENERAL

1.1 GENERAL

A. These specifications shall be utilized for the complete system as specified herein and as shown on the bid documents.

1.2 SCOPE OF WORK

A. These Specifications contained herein describe specific functional requirements of the CCTV system. It is not the intent of these specifications to detail and describe the exact performance of the system. The system features outlined in the Specifications are deemed mandatory for the project. References to model numbers are intended only for descriptive purposes. Systems that deviate from these Performance Specifications shall be considered alternate systems.

1. Programming at the OP Center headend required to support the new branch and maintain the overall system implementation shall be sub-contracted to Milesahead Technologies who currently maintains the district wide Milestone/Kantech implementation. Contact Tadd Dieringer, 937-630-3256 direct | mobile, 937-630-3231 fax, tadd.dieringer@milesaheadtechnology.com

B. IP based video surveillance as part of a multiple buildings/multiple sites implementation.

1. The system shall provide a true client-server architecture enabling the total system to appear as a single logical device regardless of the number of cameras or individual NVS/NVR units that are utilized across either the LAN or WAN. System shall be Multiple Site Enterprise Class.

C. Interior Camera System - System consists of multiple IP based cameras with specified housings, mounting, lenses, features, etc. throughout the building interior as indicated on the drawings and as specified herein.

D. Exterior Camera System - System consists of multiple IP based cameras with specified housings, mounting, lenses, local power supplies, features, etc. around the perimeter of the building as indicated on the drawings and as specified herein.

E. Video Management - Equipment and software to process video from all cameras and provide control/distribution as required for storage, archive, preview, and live monitoring of all video files and streams.

F. Video Recording - Equipment and software to receive, store and archive the network video from all cameras as indicated on the drawings and as specified herein.

G. Video Clients – Equipment and software to provide direct, real-time, GUI based access to live and recorded video.

H. Video Monitoring – Equipment and software to provide reception, decoding and display of real-time encoded network video.
I. Network Electronics – Provided under section 27 21 00.

J. Network Camera Cabling
   1. Data/Video Provided under section 27 15 13

K. Equipment Rack – Provided under section 27 11 00

L. Software Support – Project to include a minimum 1 year software support which will include complete software/license upgrades within the timeframe of the support and 24/7 tech support.

1.3 QUALITY ASSURANCE
   A. All system components shall be UL listed.
   B. Installation shall be in compliance with the National Electric Code and all other applicable codes. The system shall be in compliance with all FCC Rules and Regulations.
   C. All equipment described herein shall be the product of a manufacturer of established reputation and experience, who shall have produced similar equipment for a period of at least 2 years and who shall be able to refer to similar installations within a 75 mile radius now rendering satisfactory service.
   D. The manufacturer and their local agent shall show satisfactory evidence upon request that they maintain a fully equipped service center capable of furnishing adequate inspection and service to the equipment including standard replacement parts. The manufacturer and/or agent shall be prepared to offer a service contract for the maintenance of the system after the warranty period.
   E. To establish continuity in the manufacturer, like systems components (e.g. all cameras) shall be the standard product of one manufacturer. The manufacturer will have a minimum of two (2) years’ experience in the manufacture of products specified.
   F. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.

1.4 CONTRACTOR QUALIFICATIONS
   A. The Closed Circuit Television System shall be furnished, installed and programmed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the CCTV contractor to utilize a sub-contractor for any portion of the work, unless the subcontractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.
   B. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.
   C. The Contractor shall employ factory trained service personnel for the service and maintenance of the system.
D. The Contractor shall have had a minimum of 1 year experience with the specified CCTV system. This experience shall include having completed a minimum of 2 installations in the past 12 months of similar size and scope. The Contractor shall provide references and contact information for the project sites in which the qualifying installations occurred.

1.5 Shop Drawings - Submit shop drawings including product data sheets and wiring diagrams per requirements in the General Conditions including the following:

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

C. Job specific wiring diagrams.

D. 30x42 floor plans at a scale of not less than 1/8 inch =1 foot-0 inches showing the location of all items of equipment. Drawings shall also indicate each location where electrical power is required, and the specific configuration of that power connection (voltage, plug type, mounting height, etc.)

PART 2 - PRODUCTS

2.1 CAMERAS

A. The following sub-paragraphs define the basic camera/lens/housing types and minimum performance specifications that must be met by the selected products. The contract documents indicate which of these features/functions/housings/etc. must be included with each specific camera.

B. IP based, IPv6 compliant, Cameras shall be Open Network Video Interface Forum (ONVIF) 2.3 Profile “S” compliant (PTZ, audio and Metadata).

1. Camera shall have removable media storage which is comprised of purpose built minimum micro SDHC/SDXC cards that have been optimized for 24/7 video storage and retrieval with ext4 file system, 20MBs read/write speed, up to 128GB capacity, Configure recording stream onto card at 3Mbps max, constant bit rate.


C. Environment

1. Exterior Domes – Housing shall be IP66 rated. Housings shall utilize internal heater, blower.

2. Interior Domes – Housings shall be heavy duty and shall utilize smoked polycarbonate domes. Unless otherwise noted, all interior cameras shall be unitized domes.

3. Vandal Resistant – Housings shall utilize all vandal/tamper resistant hardware and impact resistant polycarbonate domes.
D. Mounting

1. Surface – Wall. Unit shall mount on directly on wall surface/utilizing a wall mounted arm to a recessed electrical outlet box as indicated on the drawings.
2. Surface - Ceiling. Unit shall mount on surface of ceiling to either an electrical outlet box or directly on the ceiling surface as indicated on the drawings.
3. Recessed – Ceiling. Unit shall mount recessed in an accessible ceiling via the use of ceiling grid support hardware or shall be recessed directly into a fixed ceiling system with appropriate hardware.

E. Imager/Resolution

1. IP - Megapixel
   a. Imager shall be color progressive scan.
   b. Camera shall produce maximum resolution as indicated in camera schedule. Camera shall produce full resolution at up to 30 ips.
   c. Camera shall utilize Electronic shutter, dynamic backlight compensation, automatic gain control, automatic White balance.
2. Sensitivity - Interior – 0.7 LUX

F. Lens

1. Refer to drawings for specific lens requirements for each camera.
2. Vari-focal – Lens to be high resolution, Aspherical, multicoated with adjustable zoom, focus and iris. Focal length range as specified on drawings
3. Mega-pixel – Lens to be mega-pixel compatible, hybrid aspherical maintaining image resolution from center to edge, multicoated with adjustable zoom, focus and iris. Lens resolution rating shall be matched to camera resolution.
4. All cameras shall utilize a motorized lens for zoom/auto/back focus.
5. All cameras shall utilize an automatic Iris control for F-stop/depth of field control.

G. Enhanced Features – Refer to drawings and camera schedule for additional special feature requirements such as Low Light Sensitivity, Wide Dynamic Range, PTZ, and Day/Night.

1. Wide Dynamic Range – Camera to utilize electronic shutter combined with taking multiple images at various shutter settings. The camera shall then re-combine the images utilizing an algorithm to provide enhanced dynamic range via on-board DSP.
2. Low Light – Light Sensitivity 0.1 lux at f1.3 or better.
3. Day/Night – The camera shall utilize a true (not digitally synthesized) low light operation which switches the camera from color to B/W mode by removing the IR cut filter. Low light sensitivity shall be increased in night mode to 0.06lux minimum. D/N feature shall be automatic and not switched manually. Camera to utilize enhanced day/night lens (IR corrected) and imager to prevent focus issues when the IR cut filter is removed. Camera to also utilize automatic back-focus.
4. Pan/Tilt/Zoom – Camera shall utilize highly reliable, heavy duty rated mechanism for true 360deg panning, 0-90deg tilt with minimum 1deg/s and max 300deg/s pan and tilt speeds. Zoom lens shall be as indicated on drawings. Camera to be fully programmable including home position minimum 25 presets, and tours. Unless otherwise noted, all PTZ cameras to be incorporated in unitized domes (autodomes).
5. IR Illuminator – Exterior Camera shall include IR LED illuminators with minimum range of 60ft. Cameras with integral IR shall utilize an IR “shield” coating to prevent internal reflections of IR on dusty or dirty dome housings.

H. Connectivity

1. IP Cameras – Camera to utilize integral NIC for 100MBs minimum Ethernet connection.

I. Power

1. IP - Interior cameras to utilize IEEE 802.3af Power over Ethernet (PoE).
2. Analog – Interior cameras to utilize centrally distributed multi-circuit low voltage camera power supplies with individual fused outputs.
3. All exterior cameras to be provided with surge arrestors on the power/signaling cabling.

J. Manufacturers - The following list of manufacturers are considered approved for use provided the individual camera selections conform at a minimum to the above listed specifications:

1. IP/Megapixel - American Dynamics, Avigilon, Axis, Bosch, Vicon, Hanwha.

2.2 VIDEO MANAGEMENT SYSTEM

A. The video management platform shall consist of the following modules which may be deployed as a “1” box solution (for smaller systems) or purpose built servers (typically for larger systems):

1. Network Video Server (NVS)
2. Network Video Recording/Archiving
3. Network Video Client
4. Network Video Monitoring

B. Network Video Server (NVS)

1. For the purposes of this specification, NVS shall refer to a system of Hardware, Software and Licenses to receive, process and distribute:
   a. Live video from remote IP CCTV cameras (or analog cameras attached to encoders) to network attached video recorders and archiving.
   b. Live and recorded video to User Client workstations.
   c. Live and recorded video to video display and monitoring equipment.
2. The NVS shall provide the centralized management of the CCTV system including rights and privileges, system event and error logging, system wide reporting database, error and alarm processing, default system time server, and distributed administration of all remote devices.
3. NVS shall provide full compatibility with all associated camera controls including PTZ, focus, menu and settings. NVS shall be fully compatible with all video streams and compression algorithms for all associated cameras.
4. Manage alarms, events, and alerts. Provide system monitoring and reports.
5. Provide Policy management to enable administrators to assign detailed privileges to user and user group accounts for local and remote access.
6. Provide Interactive graphical site and building maps which include user interactive camera icons for real time interface.
7. Hardware – System shall utilize rack mounted form factor with power supply, RAID 5 HDD, hot swappable, 1TB minimum System Storage, integrated DVD-RW, dual gigabit NICs, and keyboard/monitor/mouse ports. Where NVS provides recording functions as well, storage shall be increased as required to provide the minimum specifications as listed in the NVR section below.

C. Network Video Recorder (NVR)

1. For the purposes of this specification, NVR shall refer to a system of Hardware, Software and Licenses to receive, record, and archive video from remote IP CCTV cameras.
2. NVR shall be fully compatible with all video streams and compression algorithms for all associated cameras.
3. Hardware – System shall utilize rack mounted form factor with RAID 6 HDD, hot swappable HDD, integrated DVD-RW, dual gigabit NICs, and keyboard/monitor/mouse ports.
   a. Hardware shall be purpose built for processing and recording video surveillance. Hardware shall be optimized for the non-linear, constant write environment of network video. The use of generic “file servers” or hardware with general duty hard drives will not be acceptable.
4. Storage – Provide storage as required to support a minimum of sixty (60) days for all associated cameras for each NVR based upon the following criteria:
   a. Frame Rate per camera – 7 ips
   b. Resolution – Maximum resolution for each individual camera.
   d. Fixed Cameras recording mode - Motion Recording – 24x7, TOD, 50 percent, As required at each individual camera.

D. Map Functions

1. Provide Smart Map functionality, fully programmed to include all cameras on the system. Map functions shall support seamless geo-navigation services such as Bing, Google and OpenStreetMaps as well as geo-referenced GIS maps and CAD drawings, with drilldown possibilities to the classic maps.
2. Contact Architect/Engineer for DWG/PDF files of site plans and floor plans for use.
3. Scope includes all programming required for site plan with drill downs to each building/level and interactive camera icons on each.

E. Milestone XProtect Professional

2.3 RACKS/CABINETS – REFER TO SECTION 27 11 00 FOR RACK INFORMATION.

2.4 Provide a combination 15 inch color TFT display with native 1024 x 768 resolution, 103-key keyboard, built-in Logitech trackball or touchpad, (support for AT/XT, PS/2, USB and UNIX.) in a rack mounted pull-out drawer. Unit shall be rack mountable in a single rack space.

A. Acceptable Manufacturers – Acnodes, Rose, APC, Raritan, Panduit, HP.

B. Provide all required 120V power distributed through rack as required by installed equipment from local, dedicated, 120V receptacle in room. All equipment except the modulators and the keyboard/monitor/mouse are to be fed from the UPS unit(s).
C. Final rack configuration including rail width, useable depth, weight loading, etc. to be carefully coordinated with installed equipment prior to ordering.

2.5 CCTV DATA/VIDEO CABLING

A. Refer to section 27 15 13 Communications Copper Horizontal Cabling.

2.6 NETWORK ELECTRONICS – REFER TO 27 21 00 NETWORK ELECTRONICS

2.7 CABLE MANAGEMENT SYSTEM

B. Provide pre-manufactured cable supports. Cable supports shall be secured to building structure through threaded rod, beam clamps or other UL approved supports as required by site conditions. Components shall provide a minimum cable support point spacing of 48 inches.

C. Cable management devices must be sized to accommodate 100 percent spare capacity of the final installed cable base.

D. Cable management system shall be secured to building structure utilizing manufactured approved methods and hardware.

E. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building’s structure such as beams, joists, etc. to hang cable from will not be acceptable.

F. Bridle rings shall not be acceptable.

G. Manufactured by Panduit, Caddy, Mineralac or B-Line.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Install systems in accordance with UL, NEC and all other applicable codes. Install system to comply with drawings and final shop drawings in compliance with manufacturer instructions. Provide all required hardware and labor for rack mounting of head-end system components.

B. Refer to plans for locations and quantities of equipment. Equipment locations shown on plans will be required to be field coordinated to ensure proper system operation. The contractor shall provide adequate costs in the bid to locate interior cameras within 10 feet in any direction of the location indicated on the bid drawings. Exact location of each camera shall be coordinated with the owner in the field prior to installation. This coordination shall include a site survey with the owner in which the use of a field of view comparator is employed.

C. No items of equipment shall be installed in such a manner as to void or reduce the proper operating characteristics of individual components or of the system. Camera placement shall be coordinated with glass and exterior exposures to reduce or eliminate the requirement for sever back light compensation.
D. Perform all work under the on-site supervision of a factory authorized trained technician. It shall be the responsibility of the technician to check, inspect and adjust this installation to the engineer’s and owner approval. A CSR of the installing contractor or manufacturer shall train the owner’s personnel on the proper operation and maintenance of the equipment. Perform all work in conjunction with this installation in accordance with good engineering practices as established by NEC.

E. Camera Mounts: The Contractor shall install the camera mounts as specified by the manufacturer and as shown; provide mounting hardware sized appropriately to secure the mount, camera and housing, provide electrical and signal transmission cabling to the mount location as specified.

F. Cameras: The Contractor shall install the cameras with power and signal lines to the camera; aim camera to give field of view as required by owner.

G. Monitors: The Contractor shall install the monitors as shown and specified; connect all signal inputs and outputs as shown and specified; terminate video input signals as required; and connect the monitor to AC power and video distribution equipment.

H. Video Recording Equipment: The Contractor shall install the video recording equipment as shown and as specified by the manufacturer; connect video signal inputs and outputs as shown and specified; connect alarm signal inputs and outputs as shown and specified; and connect video recording equipment to AC power.

I. Delivery of all loose equipment which is to be turned over to owner shall be carefully coordinated and scheduled with owner prior to shipment.

3.2 WIRING INSTALLATION

A. CCTV wiring shall be furnished and installed in accordance with manufacturer’s recommendations in compliance with all Local, State and National codes. This contract shall be responsible for furnishing and installing all required cabling between components to form a complete and operational system meeting all the requirements of this specifications.

B. Provide firestop material and seal all cable penetrations in the building.

C. All wiring between devices shall be run open wired above accessible ceilings. Where existing cable management systems are in place and there is adequate capacity to install the CCTV wiring, the contractor may utilize these pathways providing they have coordinated with all other wiring contractor on site. Where multiple runs are required all cables shall be bundled with approved cable ties on four foot centers.

D. Where pathways do not exist for SMS wiring, this contract shall be responsible for providing all required cable management systems such as J-hooks to support communications cabling to meet building codes and manufacturer’s recommendations.

E. Cables shall not be laid upon ceilings or supported in a manner that would violate any codes or standards.

F. All cabling installed in ceiling spaces that are used for air distribution plenums shall be UL plenum rated.
G. All control and signal cable shall be installed continuous and without splices. Provide appropriate connectors or pre-manufactured cables for each application.

3.3 PROGRAMMING

A. It is the Contractor’s responsibility to program the system in this section according to the Owner’s wishes. This involves camera labeling, camera operation sequences, camera and recorder schedules, etc. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming. This programming agreement shall then be written out in detail and forwarded to the Engineer for approval. After approval is granted, proceed with final programming.

B. Each building shall have the following minimum programming:

C. Camera labels programmed in each NVS/NVR.

D. Camera record rates based upon TOD schedules, alarm events, motion events.

E. Camera motion detection recording based upon TOD schedules. Motion detection scene masking.

F. PTZ cameras – Home position, tours, alarm pre-sets.

G. Camera username/password changed from the default to owner selected.

H. Additional programming at each building shall include set-up of graphical floor plans with interactive camera icons for all cameras local to that building. District NOC shall include set-up of graphical floor plans with interactive camera icons for all sites.

I. Set-up of passwords and a minimum of four (4) user access levels including assignment of specific privileges for each user access level.

3.4 IDENTIFICATION/LABELING

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.

B. The contractor shall be responsible for generating and programming the labeling for camera information within the recorder software.

C. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.5 SITE TESTING

A. General: The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all site testing. The Owner will witness all performance verification.

B. Contractor's Field Testing: The contractor shall place the entire system into operation and shall field verify that all aspects of the CCTV system including camera video, recording
schedules, alarm events, GUI operation, System administration, etc. At the completion of testing, the contractor shall produce a written document indicating successful system testing.

C. Performance Verification Test: The Contractor shall demonstrate to the owner that all aspects, features and functions of the completed CCTV system comply with the contract requirements. The performance verification test, as specified, shall not be started until receipt by the Contractor of written permission from the Owner, based on the Contractor's Field Testing sign-off. The Owner may terminate testing at any time when the system fails to perform as specified.

3.6 TRAINING REQUIREMENTS

A. Provide the owner with a minimum of 4 hours of training designed to make all users familiar with the operation of the system.

B. Provide all training and utilize specified manuals and record documentation. All training shall be provided at the project site and coordinated with the Owner.

C. Training shall utilize the equipment provided at the project site. Coordinate use, time and availability of equipment with the Owner.

D. Demonstrate adjustment, operation and maintenance of the system including each component and control.

E. This training period shall be scheduled with the Owner after the successful completion of the system.

3.7 AS BUILT DOCUMENTATION

A. Copies of all approved shop drawings with the Engineer’s stamp.

B. Owner’s manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner’s manuals. CDs containing electronic versions of owner’s manuals must contain the proper software viewers for each document type.

C. Technology floor plan/site drawings updated with final as-Built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.

D. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

E. Provide statement of warranty.

3.8 WARRANTY
A. Warrant all workmanship, equipment, material and software entering into this contract for a period of three (3) years from the date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Provide statement of this warranty with the O&M manuals.

B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

C. The Contractor shall be responsible to provide service during normal working hours within (4) hours after notification by the Owner for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of 25 percent or more of system component operation, or the loss of the video switcher or other head-end equipment. Provide an on-site authorized factory technician within 24 hours if required.

3.9 CERTIFICATION

A. Upon completion of the testing, the manufacturer or representative shall issue to the Owner a letter of certification attesting to the fact that he has tested and adjusted the system, that all components are properly installed and free of defects, and that the system is in compliance with this specification.

END OF SECTION 282301
SECTION 28 31 11 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fire-alarm control unit.
   3. System smoke detectors.
   4. Nonsystem smoke detectors.
   5. Heat detectors.
   7. Magnetic door holders.
  10. Digital alarm communicator transmitter.

B. Related Requirements:
   1. Section 280513 "Conductors and Cables for Electronic Safety and Security" for cables
      and conductors for fire-alarm systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.

B. Shop Drawings: For fire-alarm system.
   1. Comply with recommendations and requirements in the "Documentation" section of the
      "Fundamentals" chapter in NFPA 72.
   2. Include plans, elevations, sections, details, and attachments to other work.
   3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required
      clearances, method of field assembly, components, and locations. Indicate conductor
      sizes, indicate termination locations and requirements, and distinguish between factory
      and field wiring.
   4. Detail assembly and support requirements.
   5. Include voltage drop calculations for notification-appliance circuits.
   6. Include battery-size calculations.
   7. Include input/output matrix.
   8. Include statement from manufacturer that all equipment and components have been tested
      as a system and meet all requirements in this Specification and in NFPA 72.
   9. Include performance parameters and installation details for each detector.
  10. Verify that each duct detector is listed for complete range of air velocity, temperature,
      and humidity possible when air-handling system is operating.
11. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
   a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
   b. Show field wiring required for HVAC unit shutdown on alarm.
   c. Locate detectors according to manufacturer's written recommendations.

12. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:
   1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
   2. Shop Drawings shall be prepared by persons with the following qualifications:
      a. Trained and certified by manufacturer in fire-alarm system design.
      b. NICET-certified, fire-alarm technician; Level III minimum.
      c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
   2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
   3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.

C. Field quality-control reports.

D. Sample warranty.
1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:

   a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
   b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
   c. Complete wiring diagrams showing connections between all devices and equipment.
   d. Riser diagram.
   e. Record copy of site-specific software.
   f. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

      1) Equipment tested.
      2) Frequency of testing of installed components.
      3) Frequency of inspection of installed components.
      4) Requirements and recommendations related to results of maintenance.
      5) Manufacturer's user training manuals.
   g. Manufacturer's required maintenance related to system warranty requirements.
   h. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.

C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).
1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
   1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
   2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.

C. Automatic sensitivity control of certain smoke detectors.

D. All components provided shall be listed for use with the selected system.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
   2. Heat detectors.
   3. Smoke detectors.
   4. Duct smoke detectors.
   5. Carbon monoxide detectors.
   6. Automatic sprinkler system water flow.
   7. Fire-extinguishing system operation.
   8. Fire standpipe system.
   9. Dry system pressure flow switch.

B. Fire-alarm signal shall initiate the following actions:
   1. Continuously operate alarm notification appliances.
   2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
   3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
7. Close smoke dampers in air ducts of designated air-conditioning duct systems.
8. Activate preaction system.
9. Recall elevators to primary or alternate recall floors.
10. Activate elevator power shunt trip.
11. Activate emergency lighting control.
13. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:
   1. Valve supervisory switch.
   2. High- or low-air-pressure switch of a dry-pipe or preaction sprinkler system.
   3. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:
   1. Open circuits, shorts, and grounds in designated circuits.
   2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating
      devices.
   3. Loss of communication with any addressable sensor, input module, relay, control
      module, or remote annunciator.
   4. Loss of primary power at fire-alarm control unit.
   5. Ground or a single break in internal circuits of fire-alarm control unit.
   6. Abnormal ac voltage at fire-alarm control unit.
   7. Break in standby battery circuitry.
   8. Failure of battery charging.
   9. Abnormal position of any switch at fire-alarm control unit or annunciator.

E. System Supervisory Signal Actions:
   1. Initiate notification appliances.
   2. Identify specific device initiating the event at fire-alarm control unit and remote
      annunciators.
   3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote
      alarm receiving station.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of
   earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts
      from the device when subjected to the seismic forces specified and the unit will be fully
      operational after the seismic event."
2.4 FIRE-ALARM CONTROL UNIT

A. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

C. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Pathway Class Designations: NFPA 72, Class B.

D. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

E. Elevator Recall:

1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
   a. Elevator lobby detectors except the lobby detector on the designated floor.
   b. Smoke detector in elevator machine room.
   c. Smoke detectors in elevator hoistway.
2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

F. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

G. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory.

H. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

I. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters and digital alarm radio transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

J. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

2.5 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38.

1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.

2. Station Reset: Key- or wrench-operated switch.

2.6 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.

2. Detectors shall be two-wire type.

3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.

5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.

7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
   a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.
   b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).
   c. Multiple levels of detection sensitivity for each sensor.
   d. Sensitivity levels based on time of day.

B. Photoelectric Smoke Detectors:
   1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
   2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
      a. Primary status.
      b. Device type.
      c. Present average value.
      d. Present sensitivity selected.
      e. Sensor range (normal, dirty, etc.).

C. Ionization Smoke Detector:
   1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
   2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
      a. Primary status.
      b. Device type.
      c. Present average value.
      d. Present sensitivity selected.
      e. Sensor range (normal, dirty, etc.).

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
   1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
   2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
      a. Primary status.
      b. Device type.
c. Present average value.

d. Present sensitivity selected.

e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.

4. Each sensor shall have multiple levels of detection sensitivity.

5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.


2.7 CARBON MONOXIDE DETECTORS

A. General: Carbon monoxide detector listed for connection to fire-alarm system.

1. Mounting: Adapter plate for outlet box mounting.

2. Testable by introducing test carbon monoxide into the sensing cell.

3. Detector shall provide alarm contacts and trouble contacts.

4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.

5. Comply with UL 2075.

6. Locate, mount, and wire according to manufacturer's written instructions.

7. Provide means for addressable connection to fire-alarm system.

8. Test button simulates an alarm condition.

2.8 NONSYSTEM SMOKE DETECTORS

A. General Requirements for Nonsystem Smoke Detectors:

1. Nonsystem smoke detectors shall be listed as compatible with the fire-alarm equipment installed or shall have a contact closure interface listed for the connected load.

2. Nonsystem smoke detectors shall meet the monitoring for integrity requirements in NFPA 72.

B. Single-Station Smoke Detectors:

1. Auxiliary Relays: One Form C, rated at 0.5 A.

2. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet (3 m) according to UL 464.


4. Heat sensor, 135 deg F (57 deg C) combination rate-of-rise and fixed temperature.

5. Test Switch: Push to test; simulates smoke at rated obscuration.

6. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.

7. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
8. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
9. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.

C. Single-Station Duct Smoke Detectors:

1. Comply with UL 268A; operating at 120-V ac.
2. Sensor: LED or infrared light source with matching silicon-cell receiver.
   a. Detector Sensitivity: Smoke obscuration between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) when tested according to UL 268A.
3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. The fixed base shall be designed for mounting directly to air duct. Provide terminals in the fixed base for connection to building wiring.
   a. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; listed for use with the supplied detector.
4. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
5. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.9 HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521.
   1. Temperature sensors shall test for and communicate the sensitivity range of the device.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature or a rate of rise.
   1. Mounting: Adapter plate for outlet box mounting.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.10 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
   1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

B. Chimes: Vibrating type.
C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464.

D. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.

1. Mounting: Wall mounted unless otherwise indicated.
2. Flashing shall be in a temporal pattern, synchronized with other units.

2.11 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
3. Rating: 24-V ac or dc.
4. Rating: 120-V ac.

B. Material and Finish: Match door hardware.

2.12 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.13 ADDRESSABLE INTERFACE DEVICE

A. General:

1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.
3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.
C. Integral Relay: Capable of providing a direct signal to circuit-breaker shunt trip for power shutdown.
   1. Allow the control panel to switch the relay contacts on command.
   2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. Control Module:
   1. Operate notification devices.
   2. Operate solenoids for use in sprinkler service.

2.14 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture one telephone line and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:
   1. Verification that both telephone lines are available.
   2. Programming device.
   3. LED display.
   5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:
   1. Address of the alarm-initiating device.
   2. Address of the supervisory signal.
   3. Address of the trouble-initiating device.
   4. Loss of ac supply.
   5. Loss of power.
   6. Low battery.
   7. Abnormal test signal.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.
PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.

C. Equipment Mounting: Install fire-alarm control unit on finished floor.
   1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.
   1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Manual Fire-Alarm Boxes:
   1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
   3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.

F. Smoke- or Heat-Detector Spacing: Comply with NFPA 72.

G. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends.

H. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

I. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

J. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
K. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

L. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.

M. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.2 PATHWAYS

A. Pathways above recessed ceilings and in nonaccessible locations may be routed exposed.

1. Exposed pathways located less than 96 inches (2440 mm) above the floor shall be installed in EMT.

B. Pathways shall be installed in EMT.

C. Exposed EMT shall be painted red enamel.

3.3 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Smoke dampers in air ducts of designated HVAC duct systems.
2. Magnetically held-open doors.
3. Electronically locked doors and access gates.
4. Alarm-initiating connection to elevator recall system and components.
5. Alarm-initiating connection to activate emergency lighting control.
6. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
7. Supervisory connections at valve supervisory switches.
8. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
10. Supervisory connections at fire-extinguisher locations.
3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.5 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.6 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visual Inspection: Conduct visual inspection prior to testing.
   a. Inspection shall be based on completed record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter.
   b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.


3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

4. Test audible appliances for the private operating mode according to manufacturer's written instructions.

5. Test visible appliances for the public operating mode according to manufacturer's written instructions.

6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

C. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

D. Fire-alarm system will be considered defective if it does not pass tests and inspections.
E. Prepare test and inspection reports.

F. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

G. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.7 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 28 31 11
SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing site utilities.
7. Temporary erosion- and sedimentation-control measures.

1.2 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.3 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises verify with Owner for location.

C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

D. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

E. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
3.3 TREE AND PLANT PROTECTION

A. General: Protect trees and plants remaining on-site according to requirements in Section 015639 "Temporary Tree and Plant Protection."

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.

3.4 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.

B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect’s written permission.

C. Removal of underground utilities is included in earthwork sections and with applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security and utilities sections and Section 024116 "Structure Demolition" and Section 024119 "Selective Demolition."

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches (450 mm) below exposed subgrade.
2. Use only hand methods for grubbing within protection zones.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth indicated in geotechnical soils report in a manner to prevent intermingling with underlying subsoil or other waste materials.
C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000
SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Preparing subgrades for slabs-on-grade, walks, and pavements.
   2. Excavating and backfilling for buildings and structures.
   4. Subbase course and base course for asphalt paving.
   5. Excavating and backfilling for utility trenches.

1.2 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.
   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
   1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
   2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.
H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.3 QUALITY ASSURANCE
A. Preexcavation Conference: Conduct conference at the project site.

1.4 PROJECT CONDITIONS
A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS
A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, Groups A-1, A-2-4, A-2-5, and A-3 according to AASHTO M 145, or a combination of these groups; free of rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145, or a combination of these groups.
   1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.
E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; meeting the specifications of ODOT item 304.

F. Engineered Fill: Existing site materials reused after required moisture adjustments and removal of deleterious material.

Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.3 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

2. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.5 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches (300 mm) each side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material, 4 inches (100 mm) deeper elsewhere, to allow for bedding course.

D. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

3. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."
3.6 SUBGRADE INSPECTION

A. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired dump truck to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.7 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi (17.2 MPa), may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.8 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.9 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches (450 mm) of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings.

D. Trenches under Roadways: Provide 4-inch- (100-mm-) thick, concrete-base slab support for piping or conduit less than 14 inches (355 mm) below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 6 inches (152 mm) of concrete before backfilling or placing roadway subbase course.

E. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch (25 mm) in any dimension, to a height of 12 inches (300 mm) over the pipe or conduit.
1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Place and compact final backfill of satisfactory soil to final subgrade elevation.

G. Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.10 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
   1. Under grass and planted areas, use satisfactory soil material.
   2. Under walks and pavements, use engineered fill.
   3. Under steps and ramps, use engineered fill.
   4. Under building slabs, use engineered fill.
   5. Under footings and foundations, use engineered fill.

3.11 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to [ASTM D 698] [ASTM D 1557]:
1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill soil material at 95 percent.

2. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 92 percent.

3. Under turf or unpaved areas, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 85 percent.

4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.13 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch (25 mm).
2. Walks: Plus or minus 1 inch (25 mm).
3. Pavements: Plus or minus 1/2 inch (13 mm).

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

3.14 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Shape subbase course and base course to required crown elevations and cross-slope grades.
2. Place subbase course and base course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
3. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to [ASTM D 698] [ASTM D 1557].

3.15 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
1. Place drainage course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.

2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.16 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.17 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.
SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold milling of existing asphalt pavement.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving.
4. Hot-mix asphalt overlay.
5. Asphalt curbs.

B. Related Requirements:

1. Section 312000 "Earth Moving" for subgrade preparation, fill material, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
2. Section 321373 "Concrete Paving Joint Sealants" for joint sealants and fillers at pavement terminations.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each paving material. Include statement that mixes containing recycled materials will perform equal to mixes produced from all new materials.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of ODOT for asphalt paving work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.
PART 2 - PRODUCTS

2.1 AGGREGATES

A. Coarse Aggregate: ASTM D 692/D 692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

B. Fine Aggregate: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

C. Mineral Filler: ASTM D 242/D 242M or AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320, PG 64-22

B. Tack Coat: ASTM D 977 emulsified asphalt, or ASTM D 2397 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

2.3 AUXILIARY MATERIALS

A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement; reclaimed, unbound-aggregate base material; and recycled tires, asphalt shingles, or glass from sources and gradations that have performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials.

B. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.

2.4 MIXES

A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes; designed according to procedures in AIM 2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base Course: ODOT Item 448
3. Surface Course: ODOT Item 448
PART 3 - EXECUTION

3.1 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches (300 mm) into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).
   1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

C. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

3.2 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

3.3 PLACING HOT-MIX ASPHALT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

   1. Spread mix at a minimum temperature of 250 deg F (121 deg C).
   2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet (3 m) wide unless infill edge strips of a lesser width are required.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.
3.4 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches (150 mm).
3. Offset transverse joints, in successive courses, a minimum of 24 inches (600 mm).
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AIM-22, for both "Ending a Lane" and "Resumption of Paving Operations."

3.5 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.
3.6 ASPHALT CURBS – Not used

3.7 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Replace and compact hot-mix asphalt where core tests were taken.

C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.9 WASTE HANDLING

A. General: Handle asphalt-paving waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

END OF SECTION 321216
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Driveways.
2. Roadways.
3. Parking lots.
4. Curbs and gutters.
5. Walks.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

C. Samples: For each exposed product and for each color and texture specified.

D. Other Action Submittals:

1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.3 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.
PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT
   A. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.

2.2 CONCRETE MATERIALS
   A. Concrete materials shall conform to ODOT Item 452 for pavements and ODOT, Item 608 for walks and curb ramps, and ODOT Item 609 for curbing.

2.3 CURING MATERIALS
   A. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

2.4 RELATED MATERIALS
   A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.

2.5 PAVEMENT MARKINGS
   A. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than 45 minutes.

2.6 CONCRETE MIXTURES
   A. Prepare design mixtures, proportioned according to ODOT Item 452 for pavements and ODOT, Item 608 for walks and curb ramps, and ODOT Item 609 for curbing.
   B. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions. Color shall be approved by the Owner.
   C. Stamped patterns shall be approved by the Owner prior to starting work.
SECTION 321723 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes painted markings applied to asphalt and concrete pavement.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.2: For interior, field-applied, pavement-marking paints, documentation including printed statement of VOC content.

C. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:

   1. Aexcel Inc.
   2. Benjamin Moore & Co.
   5. Conco Paints.
   6. Coronado Paint; Division of INSL-X Products Corporation.
  10. Frazee Paint.
  11. General Paint.
  15. Miller Paint.
17. PPG Industries.
18. Pratt & Lambert.
20. Rohm and Haas Company; a subsidiary of The Dow Chemical Company.
22. Sherwin-Williams Company (The).

2.2 PAVEMENT-MARKING PAINT

A. Pavement-Marking Paint: MPI #97, latex traffic-marking paint.


2.3 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow paving to age for a minimum of 40 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 mm).

1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils. Apply paint so that it cannot run beneath the stencil.

END OF SECTION 321723
PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION
A. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
B. Remove loose material from compacted subbase surface immediately before placing concrete.

3.2 EDGE FORMS AND SCREED CONSTRUCTION
A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.3 JOINTS
A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness
E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch (6-mm) radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.4 CONCRETE PLACEMENT
A. Moisten subbase to provide a uniform dampened condition at time concrete is placed.
B. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, placing, and consolidating concrete.
C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

D. Screed paving surface with a straightedge and strike off.

E. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.5 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.

2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface \( \frac{1}{16} \) to \( \frac{1}{8} \) inch (1.6 to 3 mm) deep with a stiff-bristled broom, perpendicular to line of traffic.

C. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistant aggregate finish on paving surface according to manufacturer's written instructions.

1. Cure concrete with curing compound recommended by slip-resistant aggregate manufacturer. Apply curing compound immediately after final finishing.

2. After curing, lightly work surface with a steel wire brush or abrasive stone and water to expose nonslip aggregate.

3.6 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound or a combination of these.

3.7 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 1/2 inch (13 mm).
2. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
3. Surface: Gap below 10-foot- (3-m-) long, unleveled straightedge not to exceed 1/2 inch (13 mm).
4. Joint Spacing: 3 inches (75 mm).
5. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
6. Joint Width: Plus 1/8 inch (3 mm), no minus.

3.8 PAVEMENT MARKING

A. Allow concrete paving to cure for a minimum of 28 days and be dry before starting pavement marking.

B. Sweep and clean surface to eliminate loose material and dust.

C. Apply paint with mechanical equipment to produce markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 mm).

3.9 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

C. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.
SECTION 334100 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe and fittings.
   2. Channel drainage systems.
   3. Encasement for piping.
   5. Cleanouts.
   7. Expansion joints.
   8. Catch basins.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:
   1. Manholes: Include plans, elevations, sections, details, frames, and covers.
   2. Catch basins and stormwater inlets. Include plans, elevations, sections, details, frames, covers, and grates.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.

B. Field quality-control reports.

1.4 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

   1. Notify Architect and Owner no fewer than four days in advance of proposed interruption of service.
   2. Do not proceed with interruption of service without Architect’s and Owner’s written permission.
PART 2 - PRODUCTS

2.1 PE PIPE AND FITTINGS

A. Corrugated PE Pipe and Fittings NPS 12 to NPS 60 (DN 300 to DN 1500): AASHTO M 294M, Type S, with smooth waterway for coupling joints.
   
   1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.

2.2 CONCRETE PIPE AND FITTINGS

A. Nonreinforced-Concrete Sewer Pipe and Fittings: ASTM C 14 (ASTM C 14M), Class 3, with bell-and-spigot or tongue-and-groove ends and gasketed joints with ASTM C 443 (ASTM C 443M), rubber gaskets.

2.3 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
   
   1. For Concrete Pipes: ASTM C 443 (ASTM C 443M), rubber.
   3. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   4. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:
   
   1. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:
   
   1. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:
   
   1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.
2.4 CLEANOUTS

A. Plastic Cleanouts:
   1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.5 MANHOLES

A. Standard Precast Concrete Manholes:
   1. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
   2. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
   3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
   4. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (102-mm) minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
   5. Riser Sections: 4-inch (102-mm) minimum thickness, and lengths to provide depth indicated.
   6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
   8. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
   9. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
   10. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:
   1. Description: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (102-mm-) minimum width flange and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
   2. Material: ASTM A 536, Grade 60-40-18 ductile iron unless otherwise indicated.

2.6 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R (ACI 350M/350RM), and the following:
   1. Cement: ASTM C 150, Type II.

B. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.
   2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
   1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
      a. Invert Slope: 2 percent through manhole.
   2. Benches: Concrete, sloped to drain into channel.
      a. Slope: 4 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water/cementitious materials ratio.
   2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.7 CATCH BASINS

A. Standard Precast Concrete Catch Basins:
   1. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.

2.8 PIPE OUTLETS

A. Head Walls: Cast-in-place reinforced concrete, with apron and tapered sides.

B. Riprap Basins: Broken, irregularly sized and shaped, graded stone according to NSSGA's "Quarried Stone for Erosion and Sediment Control."
   1. Average Size: NSSGA No. R-3, screen opening 2 inches (51 mm).
   2. Average Size: NSSGA No. R-4, screen opening 3 inches (76 mm).
   3. Average Size: NSSGA No. R-5, screen opening 5 inches (127 mm).
PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure drainage piping according to the following:

1. Install piping pitched down in direction of flow.
2. Install piping NPS 6 (DN 150) and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
4. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
5. Install ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
6. Install PE corrugated sewer piping according to ASTM D 2321.
7. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
8. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
9. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

G. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105:
2. Hubless cast-iron soil pipe and fittings.
3. Ductile-iron pipe and fittings.
4. Expansion joints.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:

4. Join ductile-iron culvert piping according to AWWA C600 for push-on joints.
5. Join ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
6. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
7. Join PVC corrugated sewer piping according to ASTM D 2321 for elastomeric-seal joints.
10. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set with tops 1 inch (25 mm) above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.
B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere unless otherwise indicated.

3.6 CATCH BASIN INSTALLATION

A. Set frames and grates to elevations indicated.

3.7 STORMWATER INLET AND OUTLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.

B. Construct riprap of broken stone, as indicated.

C. Install outlets that spill onto grade, anchored with concrete, where indicated.

D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.

E. Construct energy dissipaters at outlets, as indicated.

3.8 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.9 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Section 221413 "Facility Storm Drainage Piping."

B. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch (150-mm) overlap, with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).

2. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).

3. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to
conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.

a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20.7 MPa) unless otherwise indicated.
b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

C. Pipe couplings and expansion joints with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.

a. Shielded flexible couplings for same or minor difference OD pipes.
b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.10 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (610 mm) of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:
   a. Alignment: Less than full diameter of inside of pipe is visible between structures.
   b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
   c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
   d. Infiltration: Water leakage into piping.
   e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours’ advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
   a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
   b. Option: Test plastic piping according to ASTM F 1417.
   c. Option: Test concrete piping according to ASTM C 924 (ASTM C 924M).

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION 334100