



XAVIER
UNIVERSITY

BUENGER HALL RENOVATION



M.H. MALTINSKY, LICENSE #10106
EXPIRATION DATE 12/31/2017

SPECIFICATIONS

ISSUED FOR BIDDING AND PERMIT

FEBRUARY 16, 2017



glaserworks

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NOT APPLICABLE

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NOT APPLICABLE



BID FORM

Buenger Hall Renovation

(To be completed for all bids)
(Please type or print)

BIDDER (FIRM) NAME: _____

CONTACT NAME: _____

PHONE: _____

EMAIL: _____

PROJECT: Buenger Hall Renovation
Xavier University

BIDS DUE: **Friday March 10th, 2017** at 10:00 am local time

PRE-BID WALK THRU: **Thursday February 23rd, 2017** at 1:00 pm local time
Thursday March 2nd, 2017 at 1:00 pm local time
Meet outside Buenger Hall, then assemble in Basement

SUBMIT BIDS TO: Joe Frecker
Xavier University
Office of Physical Plant

Mailing Address 3800 Victory Parkway
Cincinnati, Ohio 45207-7711

Delivery Address Xavier Field Office
1507 Dana Avenue
Cincinnati, Ohio 45207

Office Phone 513-745-1083
Mobile Phone 513-477-0840
Fax 513-745-3669
Email freckerj@xavier.edu

INSTRUCTIONS TO BIDDERS:

1. This is a tax-exempt project. Certificates of tax exemption shall be provided to successful Bidders upon request after execution of a Contract.
2. Bids shall be submitted in sealed, opaque envelopes in accordance with the above named place and time. Mark Envelope: “Xavier University Buenger Hall Renovation Bid; attention Joe Frecker.”
3. Bid Submission:
 - a. Bids must be submitted on this Bid Form. Bids may not be submitted by facsimile. Failure to use this Bid Form may disqualify your Bid.
 - b. All blank spaces on this Bid Form shall be completed, in ink or typewritten, in words and figures, and in figures only where no space is provided for words, and signed by the Bidder. The wording on the Bid Form shall be used without change, alteration or addition. Any change in the wording or omission of specified accompanying documents may cause the bid to be rejected. Bidders shall note receipt of Addenda on the Bid Form.
4. Clarification of Bidders’ Questions
 - a. **Questions** for the Project shall be directed to Joe Frecker at Xavier University, freckerj@xavier.edu 745-1083 or Lynn Wyrick at Glaserworks Architecture lwyrick@glaserworks.com 665-9555
 - b. Each bidder is responsible for calling to the attention of the Architect any ambiguities, inconsistencies, errors, or omissions, which occur in the Contract Documents for its part of the Work. If the bidder fails to request clarification, the bidder will be expected to overcome such conditions without additions to the bid amount.
 - c. Prospective bidders with questions as to the true meaning of any part of the Drawings, Specifications, or other Contract Documents shall submit to the Architect not less than three (3) business days prior to the closing time for acceptance of bids, a written request for interpretation and clarification.
 - d. Bidders are instructed to request interpretations and the issuance of addenda if the Contract Documents call for materials, equipment, or methods that adversely affect the cost or quality of the Project or are unavailable.

5. The Owner reserves the right to reject any and all bids, to accept the bid which it deems to be in the best interest of the University, even if it is not the lowest, to waive any formalities or irregularities in bidding, or to advertise for new bids if in its judgment the best interests of the University would be promoted thereby.
6. The following items are by Owner. Bidders to include coordination with their work:
 - a. Dumpsters
 - b. Appliances
7. Include all labor, materials, hoisting, stocking, layout, man lifts, trash removal, etc to complete your scope of the work. Contractors to remove debris from site on a daily basis.
8. Bidder's Examination and Representation
 - a. Before submitting a bid, each bidder should carefully examine the documents and the construction site and inform itself of the limitations and conditions related to the Work covered by the bid and shall include in its bid a sum to cover the cost of such items. Bidders awarded contracts will not be given extra payments for conditions that could have been determined by examining the site and documents.
 - b. It is the purpose and intent of the Contract Documents that a complete job be accomplished. It shall be each bidder's responsibility to include costs necessary to provide labor and materials for that portion of the Work bid upon, including incidentals, whether or not specifically called for in the Specifications and Drawings.
 - c. By submitting this Bid the Bidder acknowledges that he/she has visited site and verified existing conditions that may impact the Bid.
9. The Bid Documents, include, but are not limited to, the instructions to Bidders, Bid Form, Owner-Contractor Agreement, General Conditions of the Contract for the Project, Project Schedule, Drawings, and Specifications. The Bid Documents shall become the Contract Documents, as defined in the Owner-Contractor Agreement, that govern the relationship between the successful Bidder and the Owner when the Owner-Contractor Agreement is executed and will be referred to as Contract Documents throughout these instructions to Bidders.
10. Bids will be opened privately after the bid submission deadline. Early bids may be submitted prior to the scheduled bid opening.

11. Execution of Contract:

- a. Notice of Intent to Award or Notice of Award Contract. The successful bidder will be notified of the award of the contract and provided with a faxed copy of the Owner-Contractor Agreement (“Contract”) in the form of a Purchase Order.
- b. The successful Bidder will sign and return the original forms to the Owner, or as otherwise directed, for execution by the Owner. The successful Bidder will be provided with a fully executed copy of the Contract for its records.
- c. If the successful Bidder does not return the executed Contracts to the Owner within five (5) business days of its receipt of the Contract from the Owner, the Owner reserves the right to reject the bid and award the contract to the next lowest responsible bidder.

12. Addenda

- a. Any explanation, interpretation, correction or modification of the Bid Documents will be issued in writing in the form of an Addendum, which shall be the only means considered binding; explanations, interpretations, etc., made by any other means shall NOT be legally binding. All Addenda shall become a part of the Contract Documents.
- b. Contractors should submit questions to the Architect in advance, to allow sufficient time for the Architect to respond. All Addenda will be issued except as hereafter provided, and mailed or otherwise furnished to persons who have obtained Contract Documents for the Project, at least seventy-two (72) hours prior to the obtained Contract Documents for the Project, at least seventy-two (72) hours prior to the published time for the opening of bids, excluding Saturdays, Sundays and legal holidays.
- c. Copies of each Addendum will be sent only to the Contractors to whom Drawings and Specifications have been issued. Receipt of Addenda shall be indicated by Bidders in the space provided on the Bid Form.
- d. If a Bidder fails to indicate receipt of all Addenda through the last Addendum issued by the Architect on its Bid Form, the bid of such Bidder may be deemed to be responsive if:
 - i. The bid received clearly indicates that the Bidder received the Addendum, such as where the Addendum added another item to be bid upon and the Bidder submitted a bid on that item; or

- ii. The Addendum involves only a matter of form or is one which has either no effect or has merely a trivial or negligible effect on price, quantity, quality, or delivery of the item bid upon.
- e. Following the award of the initial contract, Contractor will prepare and submit a detailed schedule to the Owner. The work shall be scheduled so as not to interfere with activities within and around the building, which may be occupied during construction.

13. Bid Responsiveness; Owner's Right to Waive Defects and Irregularities

- a. The Bidder's bid shall be responsive to the Specifications for the Project in all material respects and shall contain no material irregularities or deviations from the Specifications that would affect the amount of the bid or otherwise give the Bidder a competitive advantage.
- b. The Owner reserves the right to waive any and all irregularities provided that the defects and irregularities do not affect the amount of the bid in any material respect or otherwise gives the Bidder a competitive advantage.
- c. By submitting its bid, the Bidder agrees that the Owner's determination of whether a defect or irregularity affects the amount of the bid in any material respect or otherwise gives the Bidder a competitive advantage will be final and conclusive.

14. Modification/Withdrawal of Bids

- a. **Modification.** A bidder may modify its bid by written communication to the Owner at any time prior to the scheduled closing time for receipt of bids, provided such written communication is received by the Owner prior to the bid deadline. The written communication shall not reveal the bid price, but should provide the addition or subtraction or other modification so that the final prices or terms will not be known until the sealed bid is opened. If the Bidder's written instruction with the change in bid reveal the bid amount in any way prior to the bid opening, the bid may be rejected as non-responsive.
- b. **Withdrawal Prior to Bid Deadline.** An authorized representative of the Bidder may withdraw its bid at any time for any reason prior to the bid deadline established in the Notice to Bidders. The request to withdraw shall be made in writing and submitted to the Owner, at the Owner's address. The request for withdrawal must be received by the Owner prior to the time of the bid opening.
- c. **Withdrawal After Bid Deadline**

- i. All bids shall remain valid and open for acceptance for a period of at least 60 days after the bid opening; provided, however, that a Bidder may withdraw its bid from consideration after the bid deadline when all of the following apply:
 1. the price bid was substantially lower than the other bids;
 2. the reason for the bid being substantially lower was a clerical mistake, rather than a mistake in judgment, and was due to an unintentional and substantial error in arithmetic or an unintentional omission of a substantial quantity of work, labor, or material;
 3. the bid was submitted in good faith;
 4. the Bidder provides written notice to the Owner within two (2) business days after the opening for which the right to withdraw is claimed.

BID PACKAGES:**Bid Package No. 1: ALL TRADES-**

1. All Work shall be performed in strict accordance with the drawings and specifications prepared by Xavier University dated 16 Feb 2017.
2. Coordinate with other trades to accelerate the schedule where possible.
3. Remove all debris generated by trade work to dumpster located adjacent to building. Dumpster costs by Xavier.
4. Include daily cleanup around work activities and pathway between work area to dumpster shall be kept clean at all times.
5. Xavier University zero tolerance and conformance with harassment code and accountability procedures must be complied with at all times.
6. All trade contractors are to visit the site to verify all conditions applicable to their scope of work. Submitting a bid acknowledges that a full examination has been done and that the bidder is familiar with all conditions in the building.
7. All trade contractors are to provide all necessary access equipment required to perform their work. There will be no scaffolding, lifts, ladders, or hoisting, etc. provided by the owner. Trades may choose to share their equipment if they wish.
8. All trade contractors are familiar with the work in other bid packages.
9. There are periods of no work in the schedule. Mobilizations and off days are included within the bid price.
10. Some moving and shifting of existing items may be required to perform your work. This is part of the base bid for your package. Dorm room furniture will remain in the building during renovation.
11. Materials storage areas will be very limited. Provide alternatives as necessary.
12. Coordinate utility disruptions with Xavier and perform on selective off hours if necessary.

Bid Package No. 2: GENERAL TRADES –

1. Included within this package area all items listed within **Bid Package No. 1 ALL TRADES**
2. Include all demolition except where specifically noted by other trades. Re-use existing material where indicated.
3. Include all metal studs, drywall, and finishing.
4. Include all doors, frames, hardware, and glazing.
5. Include all drywall ceilings and acoustic ceilings. See alternate description and drawing for details about base bid vs. Alternate. There is a certain amount of ceiling removal and replacement within the base bid.
6. Include site barricades and construction signage to designate the building as a construction area that is off limits to Xavier students and employees.
7. Include all plywood sheathing, gypsum sheathing and blocking shown on drawings.
8. Include block or drywall patching where demolition and the removal of existing items leaves exposed wall surfaces.
9. Include all batt insulation.

10. Include all concrete work shown on drawings.
11. Include all accessories as shown on drawings.
12. Include all signage shown on drawings.
13. Include demolition of carpet on walls as shown on drawings.
14. Include all cold formed metal framing systems and accessories.
15. Include patching of items removed on MEP drawings
16. Include access panels as shown on drawings.

Base Bid _____ \$ _____

Written Price
Figure

Alternate #1: CORRIDOR CEILINGS – For all work described in this scope, remove and replace corridor ceilings as shown on drawings.

Add _____ Deduct _____
 Cost _____ \$ _____

Written Price
Figure

Alternate #2: SUITE CEILINGS – For all work described in this scope, remove and replace suite ceilings as shown on drawings.

Add _____ Deduct _____
 Cost _____ \$ _____

Written Price
Figure

Unit Price: ACCESS PANEL – Cost to remove and replace an 8" x 8" plastic access panel in drywall wall or ceiling and patch gypsum board.

Cost _____ /EA \$ _____ /EA

Written Price
Figure

Bid Package No. 3: MASONRY–

1. Included within this package area all items listed within **Bid Package No. 1 ALL TRADES**
2. Include all masonry demolition as shown on drawings.
3. Include all new masonry partitions as shown on drawings.
4. Include the setting of door frames within masonry partitions. Knock out and tooth in where full welded frames are specified.
5. Include all anchors and flashings within the brick or block systems.
6. Provide all hoisting for this scope of work.
7. Include all backer rod and caulking for masonry joints, or where masonry abuts dissimilar materials.
8. Include all masonry patching per drawings.
9. Include patching of items to be removed on MEP drawings.
10. Carefully construct certain bearing walls per schedule and per sequence as outlined on structural drawings.



Base Bid _____ \$ _____
 Written Price Figure

Unit Price: MASONRY PATCHING – Cost to remove and replace one 4”x8”x16” block and blend to match adjacent existing surfaces.

Cost _____/EA \$ _____/EA
 Written Price Figure

Bid Package No. 4: STRUCTURAL AND MISCELLANEOUS STEEL–

1. Included within this package area all items listed within **Bid Package No. 1 ALL TRADES**
2. Furnish and install all structural steel and metal grating per the structural drawings.
3. Furnish and install all miscellaneous steel per the architectural and structural drawings. This includes but is not limited to stairs, handrails, ladders, angles, tubes, channels, etc.
4. Provide all hoisting for this scope of work.
5. Include cutting into roofing system for steel anchorage. Roof Patching is by others.
6. Include steel supports for mechanical duct support.

Base Bid _____ \$ _____
 Written Price Figure

Bid Package No. 5: MILLWORK–

1. Included within this package area all items listed within **Bid Package No. 1 ALL TRADES**
2. Furnish and install all millwork items as indicated on the drawings, including but not limited to new casework and solid surface tops in lounges, etc.
3. Furnish and install all blocking required for this scope of work.
4. Include all handicapped accessible casework per drawings.
5. Include demolition of all woodwork/casework items as shown on drawings.
6. Include removal, storage, and re-installation of existing casework per drawings.
7. Include grommets within new casework if required during shop drawing process.

Base Bid _____ \$ _____
 Written Price Figure

Bid Package No. 6: ROOFING–

1. Included within this package area all items listed within **Bid Package No. 1 ALL TRADES**
2. Include patching of all roof penetrations created by steel and MEP contractors as shown on the drawings. See Architectural, Structural, and MEP drawings.
3. Include shingle replacement in this scope of work.
4. Include all metal copings, flashings, angles, etc.



5. Provide roof safety systems as required for this work.

Base Bid _____ \$ _____
Written Price Figure

Unit Price: PLYWOOD PATCHING – Cost to remove and replace one 4”x8”x5/8” thick sheet of plywood if damaged underneath shingles.

Cost _____/EA \$ _____/EA
Written Price Figure

Bid Package No. 7: PAINTING-

1. Included within this package area all items listed within **Bid Package No. 1 ALL TRADES**
2. Include painting of new surfaces per drawings and finish schedule.
3. Include painting of all new interior walls, ceilings, etc.
4. Include masking of signs, fire alarm devices, bulletin boards, hardware, toilet accessories, woodwork, etc. Protect all adjacent items that do not receive paint.
5. Include patching and painting where demolished items leave exposed, unpainted surface.
6. Include all caulking necessary for a complete scope of work.
7. Include wall mock ups for approval prior to starting paint work.
8. Include painting of gas pipe on roof.

Base Bid _____ \$ _____
Written Price Figure

Alternate #1: CORRIDOR PAINTING – For all work described in this scope, paint corridors as shown on drawings.

Add _____ Deduct _____
Cost _____ \$ _____
Written Price Figure

Alternate #2: SUITE PAINTING – For all work described in this scope, paint suites as shown on drawings.

Add _____ Deduct _____
Cost _____ \$ _____
Written Price Figure

Bid Package No. 8: FLOORING –

1. Included within this package area all items listed within **Bid Package No. 1 ALL TRADES**
2. Include new flooring per drawings.
3. Include new base on all new wall partitions.
4. Include transition strips, resilient base, and any other accessories required.
5. Figure that night shift could be required for all flooring installation.



- 6. Include floor prep as necessary for new flooring installation.
- 7. Provide all sealants required for this scope of work.
- 8. Include all flooring demolition as shown on drawings. Demolition of Carpet on walls by General Trades Contractor.
- 9. Include resilient base on the new casework.
- 10. Include floor protection consisting of taped plastic and taped masonite over top of ALL new flooring, and removal at time directed by owner.

Base Bid _____ \$ _____
 Written Price Figure

Alternate #1: CORRIDOR FLOORING – For all work described in this scope, remove and replace corridor flooring as shown on drawings.

Add _____ Deduct _____
 Cost _____ \$ _____
 Written Price Figure

Alternate #2: SUITE FLOORING – For all work described in this scope, remove and replace suite flooring as shown on drawings.

Add _____ Deduct _____
 Cost _____ \$ _____
 Written Price Figure

Unit Price: VCT PATCHING - Provide cost per square foot to replace VCT floor tiles in small quantity with new.

Cost _____/SF \$ _____/SF
 Written Price Figure

Unit Price: DORM ROOM FLOOR REPLACEMENT - Provide cost per dorm room to replace VCT floor tiles within a dorm room with new VCT flooring to match existing.

Cost _____/RM \$ _____/RM
 Written Price Figure

Unit Price: VINYL BASE REPLACEMENT - Provide cost per dorm room to replace vinyl floor base with new to match existing.

Cost _____/RM \$ _____/RM
 Written Price Figure

Bid Package No. 9: HEATING, VENTILATION, AIR CONDITIONING

- 1. Included within this package area all items listed within **Bid Package No. 1 ALL TRADES**
- 2. Include all HVAC demolition per drawings. This includes creating and patching any hole needed for mechanical items to penetrate floor, roof, walls, casework, etc. Safely protect openings in floors.

3. Include saw cutting of precast concrete structural slabs, which requires special consideration of locations, means, and methods. Coordinate with owner and Structural Engineer.
4. Include all new interior and exterior HVAC work per drawings, including equipment, ductwork, piping, equipment, insulation, balancing, and controls.
5. Include balancing before work starts and after work completes.
6. Include all in-wall and above-ceiling fan coil units, and associated piping.
7. Remove and replace any existing ceiling that requires HVAC work above an existing ceiling that remains.
8. Include all fire dampers and balancing dampers per drawings.
9. Provide all hoisting for this scope of work.
10. Provide a complete controls system for all new units, with integration into existing controls system. Any unit in a public area to be networked. Dorm room units will not be networked, and will be stand-alone units.
11. Dorm room fan coil units shall be equipped with shut-off capability when windows are open. This feature will not be used right away and shall be disabled/bypassed for future use.
12. Ceiling mount fan coil units shall be equipped with a wireless, wall mount thermostat. Wall mount fan coil units shall have internal thermostat.
13. Seal up existing brick louver vents that are no longer being used for outdoor air.
14. Include all gas piping work shown on the drawings. This extends all the way from the Utility Plant building, to the roof of Buenger. Provide and seal all penetrations necessary.
15. Include complete exhaust duct cleaning under Alternate #H.
16. The schedule clearly indicates that multiple crews will be required to perform the work.
17. Furnish and install ERV unit. Includes hoisting.
18. Include mechanical curbs and support frames for all mechanical items
19. Include pipe labeling for all new work.

Base Bid _____ \$ _____
Written Price Figure

Proposed ERV unit manufacturer _____

Proposed Fan Coil unit manufacturer _____

Cost to use Trane Fan Coil Units and controls: Add/Deduct _____

Alternate #H: EXHAUST DUCT CLEANING – Fully clean all exhaust ductwork in the building so that it is free from dust and lint buildup.

Add _____ Deduct _____
 Cost _____ \$ _____
Written Price Figure



- 9. Include disconnection and support of lighting where ceilings are to be demolished. Provide adequate temporary lighting throughout the construction schedule.
- 10. Include all new lightning protection work per drawings. Repair areas disturbed to install this system.
- 11. Can lights to be located in the center if ceiling tile unless noted otherwise.
- 12. Include costs to hire an elevator technician for fire alarm work inside elevator shaft/cabs.
- 13. Provide bid breakdown requested below. All prices shall be complete, including material and labor, overhead and profit, etc.
- 14. Include electric installation of appliances if required.
- 15. Modify electrical systems to accommodate new work as indicated on drawings.
- 16. Electric contractor is responsible for light fixture rebate application from Duke Energy and savings should be reflected in the Base Bid pricing proposal.

Bid Breakdown:

Demolition	\$ _____
Power	\$ _____
Lighting	\$ _____
Fire Alarm	\$ _____
Lightning Protection	\$ _____
Telephone & Data	\$ _____

Total Base Bid _____ \$ _____
Written Price Figure

Alternate #1: CORRIDOR LIGHTING AND FIRE ALARM – For all work described in this scope, remove and replace corridor luminaires and fire alarm devices as shown on drawings.

Add _____ Deduct _____
Cost _____ \$ _____
Written Price Figure

Alternate #2: SUITE LIGHTING AND FIRE ALARM – For all work described in this scope, remove and replace suite luminaires and fire alarm devices as shown on drawings.

Add _____ Deduct _____
Cost _____ \$ _____
Written Price Figure

Unit Price: RECEPTACLE - Provide cost per each to replace a damaged receptacle with new. Wiring to remain.

Cost _____ /EA \$ _____ /EA
Written Price Figure

Unit Price: LIGHT SWITCH - Provide cost per each to replace a damaged light switch with new. Wiring to remain.

Cost _____/EA \$_____/EA
 Written Price Figure

Unit Price: TYPE F2 LIGHT FIXTURE - Provide cost per each to add or delete a type F2 light fixture.

Cost _____/EA \$_____/EA
 Written Price Figure

Unit Price: TYPE F4 LIGHT FIXTURE - Provide cost per each to add or delete a type F4 light fixture.

Cost _____/EA \$_____/EA
 Written Price Figure

Bid Package No. 12: FURNITURE-

1. Included within this package area all items listed within **Bid Package No. 1 ALL TRADES**
2. Include all new furniture per drawings.
3. Owner to remove existing furniture from spaces scheduled to receive new furniture.
4. Include all delivery coordination, stocking, unpacking, and setup per the layouts shown on the drawings.
5. Include a pricing breakdown indicating pricing by furniture piece number.
6. Leave plastic protection on furniture until directed by owner for removal.

Base Bid _____ \$_____
 Written Price Figure

SCHEDULE:

If this Bid is accepted, the start date for work on site shall be 5/15/17 and the Bidder shall complete the Work before 8/7/17, in accordance with the project schedule dated 2/16/17.

The Bidder understands that liquidated damages will be levied if the Work is not complete with Certificates of Occupancies in place as indicated in the Supplemental Conditions.

ADDENDA:

The undersigned acknowledges receipt of the following Addenda:

Addenda No. _____ Dated _____



Addenda No. _____ Dated _____

PROPOSAL TIME:

The Bidder agrees that this Bid shall be valid for a period of sixty (60) consecutive calendar days from the due date and unless withdrawn with written consent from Owner. Bids may be accepted or rejected during this time. Bids not accepted within said period shall be deemed rejected.

In submitting this Bid, it is hereby understood that the Owner reserves the unrestricted privilege to reject any and all bids and to waive any informalities in bidding.

ATTEST:

In consideration of the foregoing, the undersigned hereby agree that if this proposal is accepted, to enter into a contract with the owner as set forth herein, and to fully execute said contract in accord with its provisions.

Further, the undersigned acknowledges that the Bidder or Bidder's Representative has:

Visited the Job Site: Yes _____ No _____

Reviewed the Schedule/Timeframe: Yes _____ No _____

FIRM NAME: _____

BY: _____
(PRINTED NAME)

(SIGNATURE)

TITLE: _____

OFFICIAL ADDRESS

ACKNOWLEDGEMENT:

STATE OF _____)

COUNTY OF _____)



_____ being duly sworn, deposes and says

that he/she is _____ of the above _____
(Title) (Name of Organization)

and that the answers to the questions in the foregoing questionnaires and all statements therein contained are true and correct.

Subscribed and sworn to before me this _____ day of _____, 20_____

Notary Public

My Commission Expires: _____

County of Residence: _____

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SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Project information.
 - 2. Work under separate contracts.
 - 3. Owner-furnished products.
 - 4. Specification and drawing conventions.
 - 5. Miscellaneous provisions.

1.2 PROJECT INFORMATION

- A. Project Identification: Buenger Hall Renovation.
 - 1. Project Location: 3848 Ledgewood Dr., Cincinnati, Ohio 45207..
- B. Owner: Xavier University.
- C. Architect: glaserworks, 304 East 8th Street, Cincinnati, Ohio 45202..

1.3 WORK UNDER SEPARATE CONTRACTS

- A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contracts.
- B. Concurrent Work: Owner will award separate contract(s) for construction operations at Project site. Those operations will be conducted simultaneously with work under this Contract.

1.4 OWNER-FURNISHED PRODUCTS

- A. Owner will furnish products indicated. The Work includes receiving, unloading, handling, storing, protecting, and installing Owner-furnished products.
- B. Owner-Furnished Products:
 - 1. Roof shingles.
 - 2. Refrigerators.

1.5 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 2. Abbreviations: Materials and products are identified by abbreviations scheduled on Drawings.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

1.2 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."
- C. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.3 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
 - 1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
 - 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 - 3. Resubmittal Review: Allow 15 days for review of each resubmittal.
- B. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:
 - 1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 - 2. Name file with submittal number or other unique identifier, including revision identifier.
 - a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).
 - 3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.
- C. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
 - 1. Note date and content of previous submittal.
 - 2. Note date and content of revision in label or title block and clearly indicate extent of revision.

3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.
- D. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 1. Submit electronic submittals via email as PDF electronic files.
 - a. Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
 2. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 1. Submit Product Data in the following format:
 - a. PDF electronic file.
- C. 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. Submit Shop Drawings in the following format:
 - a. PDF electronic file.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
 1. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
- E. Maintenance Data: Comply with requirements specified in Section 017823 "Operation and Maintenance Data."

2.2 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect .
- B. Project Closeout and Maintenance Material Submittals: See requirements in Section 017700 "Closeout Procedures."
- C. 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 ACTION

- A. Action Submittals: Architect will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.

END OF SECTION 013300

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SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. 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.

1.2 DEFINITIONS

- A. Products: Items obtained 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. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process 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. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. 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. 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.
- C. Storage:
 - 1. Store materials in a manner that will not endanger Project structure.
 - 2. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.

3. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
4. Protect stored products from damage and liquids from freezing.

1.4 PRODUCT WARRANTIES

- A. 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:** Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 2. **Special Warranty:** Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. **Special Warranties:** Prepare a written document that contains appropriate terms and identification, ready for execution.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. **General Product Requirements:** Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, 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. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 3. Where products are accompanied by the term "as selected," Architect will make selection.
 4. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
 - 1. Installation of the Work.
 - 2. Cutting and patching.
 - 3. Progress cleaning.
 - 4. Starting and adjusting.
 - 5. Protection of installed construction.

1.2 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 construction to original conditions after installation of other work.

1.3 QUALITY ASSURANCE

- A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
 - 1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection
- B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections.
- B. In-Place Materials: Use materials for patching 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 provide a match acceptable to Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
 - 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utilities.
 - 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, 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. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. 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.
- B. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- C. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect.

3.3 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. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
 - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
- G. 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.
- H. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.4 CUTTING AND PATCHING

- A. Cutting and Patching, 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.
- 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. 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 neatly to minimum 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.
- D. 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 practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
 - 1. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize 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.
- E. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.5 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.

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 equipment for proper operation. Adjust operating components for proper operation without binding.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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 Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 017300

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Warranties.
 - 3. Final cleaning.
 - 4. Repair of the Work.

1.2 ACTION SUBMITTALS

- A. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

1.3 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.

1.4 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
 - 1. Submit list of incomplete items in the following format:
 - a. PDF electronic file. Architect will return annotated file.

1.5 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
 - 1. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
- C. Provide additional copies of each warranty to include in operation and maintenance manuals.

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: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation manuals for systems, subsystems, and equipment.
 - 2. Product maintenance manuals.

1.2 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.

1.3 CLOSEOUT SUBMITTALS

- A. Format: Submit operations and maintenance manuals in the following format:
 - 1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Architect.
 - 2. One paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves.

PART 2 - PRODUCTS

2.1 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. Use designations for systems and equipment indicated on Contract Documents.
 - 2. Operating standards.
 - 3. Operating procedures.
 - 4. Operating logs.
 - 5. Wiring diagrams.
 - 6. Control diagrams.
 - 7. Piped system diagrams.
 - 8. Precautions against improper use.
 - 9. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
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.
6. Normal shutdown instructions.
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.

2.2 PRODUCT MAINTENANCE MANUALS

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. Source Information: List each product 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 and drawing or schedule designation or identifier where applicable.
- C. Product Information: Include the following, as applicable:
1. Product name and model number.
 2. Manufacturer's name.
 3. Color, pattern, and texture.

4. Material and chemical composition.
 5. Reordering information for specially manufactured products.
- D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
1. Inspection procedures.
 2. Types of cleaning agents to be used and methods of cleaning.
 3. List of cleaning agents and methods of cleaning detrimental to product.
 4. Schedule for routine cleaning and maintenance.
 5. Repair instructions.

2.3 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- 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. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
1. Standard 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.
- C. 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 video recording, if available.
- D. 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.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

- A. 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.
- B. 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.
- C. 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 Section 017839 "Project Record Documents."
- D. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for project record documents, including the following:
 - 1. Record Drawings.

1.2 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit one set(s) of marked-up record prints.
 - 2. Submit electronic files for shop drawings serving as record drawings.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
 - 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross-reference record prints to corresponding archive photographic documentation.
 - 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Revisions to routing of piping and conduits.
 - d. Revisions to electrical circuitry.
 - e. Actual equipment locations.
 - f. Duct size and routing.

- g. Locations of concealed internal utilities.
- h. Field records for variable and concealed conditions.
- i. Record information on the Work that is shown only schematically.

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 revisions to project record documents as they occur; do not wait until end of Project.

END OF SECTION 017839

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

- A. 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.

1.2 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.
- 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. 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 as applicable to the system, equipment, or component:
 - 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. Operations manuals.
 - b. Maintenance manuals.

- c. Identification systems.
 - d. 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 training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."
- B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION

- A. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

END OF SECTION 017900

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SECTION 055119 - METAL GRATING STAIRS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes industrial-type, straight-run stairs with steel-grating treads and railings attached to metal grating stairs.

1.2 ACTION SUBMITTALS

- A. Shop Drawings: Include plans, elevations, sections, details, and attachments.
- B. Delegated-Design Submittal: For stairs, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer to design stairs and railings.
 - 1. 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 in material, design, and extent to those indicated for this Project.
- B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Uniform Load: 100 lbf/sq. ft..
 - 2. Concentrated Load: 300 lbf applied on an area of 4 sq. in..
 - 3. Uniform and concentrated loads need not be assumed to act concurrently.
 - 4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
 - 5. Limit deflection of treads, platforms, and framing members to $L/360$.
- C. Seismic Performance of Stairs: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: 1.5.

D. Stair and railing shall be OSHA-compliant.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Steel Bars for Grating Treads: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.

D. Wire Rod for Grating Crossbars: ASTM A 510.

2.3 FASTENERS

A. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

1. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 099123 "Painting."

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

2.5 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.

2. Use connections that maintain structural value of joined pieces.

B. Form exposed work with accurate angles and surfaces and straight edges.

C. Weld connections 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 to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 4 welds: good quality, uniform undressed weld with minimal splatter.

- D. Fabricate joints that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

2.6 STEEL-FRAMED STAIRS

- A. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," Industrial Class, unless more stringent requirements are indicated.
- B. Stair Framing:
 - 1. Fabricate stringers of steel channels.
- C. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual."
 - 1. Fabricate treads and platforms from welded steel grating with openings in gratings no more than 3/4 inch in least dimension.
 - 2. Surface: Serrated.
 - 3. Finish: Galvanized.
 - 4. Fabricate grating treads with rolled-steel floor plate nosing and with steel angle or steel plate carrier at each end for stringer connections. Secure treads to stringers with bolts.
 - 5. Fabricate grating platforms with nosing matching that on grating treads. Provide toeplates at open-sided edges of grating platforms. Weld grating to platform framing.

2.7 STAIR RAILINGS

- A. Comply with applicable requirements in Section 055213 "Pipe and Tube Railings."

2.8 FINISHES

- A. Finish metal stairs after assembly.
- B. 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.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- D. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. 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. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
- C. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.

3.2 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 055119

SECTION 055213 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Steel pipe railings.

1.2 ACTION SUBMITTALS

- A. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- B. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer to design railings, including attachment to building construction.
 - 1. 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 in material, design, and extent to those indicated for this Project.
- B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.

- c. Uniform and concentrated loads need not be assumed to act concurrently.
- 2. Infill of Guards:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft..
 - b. Infill load and other loads need not be assumed to act concurrently.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F.
- D. Stair and railings shall be OSHA-compliant.

2.2 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

2.3 STEEL AND IRON

- A. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

2.4 FASTENERS

- A. General: Provide the following:
 - 1. Hot-Dip Galvanized Railings: Type 304 stainless-steel or hot-dip zinc-coated steel fasteners complying with ASTM A 153/A 153M or ASTM F 2329 for zinc coating.
- B. Fasteners for Interconnecting Railing Components:
 - 1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.

2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Paint finish for Galvanized Steel: Provide products that comply with "Section 099123 " Painting."

2.6 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that are exposed to weather in a manner that excludes water. Provide weep holes where water may accumulate.
- F. Connections: Fabricate railings with welded connections unless otherwise indicated.
- G. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 - 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 flux immediately.
 - 4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- H. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- I. Close exposed ends of railing members with prefabricated end fittings.

2.7 STEEL AND IRON FINISHES

- A. Galvanized Railings:
 - 1. Hot-dip galvanize exterior steel railings, including hardware, after fabrication.
 - 2. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
 - 3. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
- C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.
- D. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- E. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting.
 - 1. Shop prime uncoated railings with primers specified in Section 099123 "Painting".

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
 - 1. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 - 2. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
- C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
- D. Adjust railings before anchoring to ensure matching alignment at abutting joints.

3.2 RAILING CONNECTIONS

- A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

3.3 ADJUSTING AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 055213

SECTION 064116 - PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plastic-laminate-faced architectural cabinets.
 - 2. Wood furring, blocking, shims, and hanging strips for installing plastic-laminate-faced architectural cabinets unless concealed within other construction before cabinet installation.
- B. Related Requirements:
 - 1. Section 123661.16 "Solid Surfacing Countertops."

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product, including panel products, high-pressure decorative laminate, adhesive for bonding plastic laminate and cabinet hardware and accessories.
- B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
 - 1. Apply AWI Quality Certification Program label to Shop Drawings.
- C. Samples for Verification:
 - 1. Plastic laminates, 8 by 10 inches, for each type, color, pattern, and surface finish.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver cabinets until painting and similar operations that could damage woodwork have been completed in installation areas. If cabinets must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

- B. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed, and indicate measurements on Shop Drawings.

1.7 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that cabinets can be supported and installed as indicated.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of architectural plastic-laminate cabinets indicated for construction, finishes, installation, and other requirements.
- B. Grade: Custom.
- C. Type of Construction: Frameless.
- D. Cabinet, Door, and Drawer Front Interface Style: Flush overlay.
- E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by woodwork quality standard.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Formica Corporation.
 - b. Wilsonart International; Div. of Premark International, Inc.
- F. Laminate Cladding for Exposed Surfaces:
 - 1. Horizontal Surfaces: Grade HGS.
 - 2. Vertical Surfaces: Grade VGS.
 - 3. Edges: Grade VGS.
- G. Materials for Semiexposed Surfaces:
 - 1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, NEMA LD 3, Grade VGS.
 - a. Edges of Plastic-Laminate Shelves: PVC edge banding, 0.12 inch thick, matching laminate in color, pattern, and finish.
 - b. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, NEMA LD 3, Grade CLS.
 - 2. Drawer Sides and Backs: Solid-hardwood lumber.

3. Drawer Bottoms: Hardwood plywood.
- H. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.
- I. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
 1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.
- J. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 1. As selected by Architect from laminate manufacturer's full range in the following categories:
 - a. Solid colors.
 - b. Wood grains.
 - c. Patterns.

2.2 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.
 1. Wood Moisture Content: 5 to 10 percent.
- B. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.
 1. Medium-Density Fiberboard: ANSI A208.2, Grade 130.
 2. Softwood Plywood: DOC PS 1, medium-density overlay.
 3. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.

2.3 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets.
- B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 100 degrees of opening.
- C. Back-Mounted Pulls: BHMA A156.9, B02011.
- D. Shelf Rests: BHMA A156.9, B04013; metal.
- E. Drawer Slides: BHMA A156.9.
 1. Grade 1 and Grade 2: Side mounted and extending under bottom edge of drawer; full-extension type; zinc-plated steel with polymer rollers.
 2. Grade 1HD-100 and Grade 1HD-200: Side mounted; full-extension type; zinc-plated-steel ball-bearing slides.
 3. For drawers not more than 3 inches high and not more than 24 inches wide, provide Grade 1.

4. For drawers more than 3 inches high but not more than 6 inches high and not more than 24 inches wide, provide Grade 1HD-100.
 5. For drawers more than 6 inches high or more than 24 inches wide, provide Grade 1HD-200.
- F. Door and Drawer Silencers: BHMA A156.16, L03011.
- G. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
1. Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base.
 2. Satin Stainless Steel: BHMA 630.
- H. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.4 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

2.5 FABRICATION

- A. Fabricate cabinets to dimensions, profiles, and details indicated.
- B. Complete fabrication, including assembly 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.
- C. Shop-cut openings to maximum extent possible to receive hardware, appliances, 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.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition cabinets to average prevailing humidity conditions in installation areas.
- B. Before installing cabinets, examine shop-fabricated work for completion and complete work as required.

3.2 INSTALLATION

- A. Grade: Install cabinets to comply with same grade as item to be installed.
- B. Install cabinets level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.
- C. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

- D. Cabinets: 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 sag, bow, or other variation from a straight line.
 2. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with No. 10 wafer-head screws sized for not less than 1-1/2-inch penetration into wood framing, blocking, or hanging strips.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean cabinets on exposed and semiexposed surfaces.

END OF SECTION

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SECTION 073113 - ASPHALT SHINGLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Asphalt shingles (furnished by Owner.)
 - 2. Underlayment.
 - 3. Metal flashing and trim.

1.2 DEFINITION

- A. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store roofing materials in a dry, well-ventilated location protected from weather, sunlight, and moisture according to manufacturer's written instructions.
- B. Store underlayment rolls on end on pallets or other raised surfaces. Do not double stack rolls.
- C. Protect unused roofing materials from weather, sunlight, and moisture when left overnight or when roofing work is not in progress.
- D. Handle, store, and place roofing materials in a manner to prevent damage to roof deck or structural supporting members.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Install self-adhering sheet underlayment within the range of ambient and substrate temperatures recommended in writing by manufacturer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Exterior Fire-Test Exposure: Provide asphalt shingles and related roofing materials identical to those of assemblies tested for Class A fire resistance according to ASTM E 108 or UL 790 by Underwriters Laboratories or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

2.2 GLASS-FIBER-REINFORCED ASPHALT SHINGLES

- A. Asphalt shingles will be furnished by Owner.

2.3 UNDERLAYMENT MATERIALS

- A. Felt: ASTM D 226/D 226M, asphalt-saturated organic felts, nonperforated.
 - 1. Type: Type I.
- B. Self-Adhering Sheet Underlayment, Polyethylene Faced: ASTM D 1970/D 1970M, minimum of 40-mil- thick, slip-resisting, polyethylene-film-reinforced top surface laminated to SBS-modified asphalt adhesive, with release backing; cold applied.

2.4 ACCESSORIES

- A. Asphalt Roofing Cement: ASTM D 4586, Type II, asbestos free.
- B. Roofing Nails: ASTM F 1667; aluminum, stainless-steel, copper, or hot-dip galvanized-steel wire shingle nails, minimum 0.120-inch- diameter, sharp-pointed, with a minimum 3/8-inch- diameter flat head and of sufficient length to penetrate 3/4 inch into solid wood decking or extend at least 1/8 inch through OSB or plywood sheathing.
 - 1. Shank: Barbed.
 - 2. Where nails are in contact with metal flashing, use nails made from same metal as flashing.
- C. Felt-Underlayment Nails: Aluminum, stainless-steel, or hot-dip galvanized-steel wire with low-profile capped heads or disc caps, 1-inch minimum diameter.

2.5 METAL FLASHING AND TRIM

- A. General: Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
 - 1. Sheet Metal: Anodized aluminum.
 - a. Color: Match existing sheet metal.
- B. Fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of the item.
 - 1. Apron Flashings: Fabricate with lower flange a minimum of 4 inches over and 4 inches beyond each side of downslope asphalt shingles and 6 inches up the vertical surface.
 - 2. Step Flashings: Existing step flashings shall remain.
 - 3. Open-Valley Flashings: Fabricate in lengths not exceeding 10 feet with 1-inch- high, inverted-V profile at center of valley and equal flange widths of 10 inches.
 - 4. Drip Edges: Fabricate in lengths not exceeding 10 feet with 2-inch roof-deck flange and 1-1/2-inch fascia flange with 3/8-inch drip at lower edge.

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.

1. Examine roof sheathing to verify that sheathing joints are supported by framing and blocking or metal clips and that installation is within flatness tolerances.
 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored; and that provisions have been made for flashings and penetrations through asphalt shingles.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

- A. General: Comply with underlayment manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
- B. Single-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Lap sides a minimum of 2 inches over underlying course. Lap ends a minimum of 4 inches. Stagger end laps between succeeding courses at least 72 inches. Fasten with felt-underlayment nails.
1. Install felt underlayment on roof deck not covered by self-adhering sheet underlayment. Lap sides of felt over self-adhering sheet underlayment not less than 3 inches in direction that sheds water. Lap ends of felt not less than 6 inches over self-adhering sheet underlayment.
 2. Install fasteners at no more than 36 inches o.c.
- C. Self-Adhering Sheet Underlayment: Install, wrinkle free, on roof deck. Comply with low-temperature installation restrictions of underlayment manufacturer if applicable. Install lapped in direction that sheds water. Lap sides not less than 3-1/2 inches. Lap ends not less than 6 inches staggered 24 inches between courses. Roll laps with roller. Cover underlayment within seven days.
1. Valleys: Extend from lowest to highest point 18 inches on each side.
- D. Metal-Flashed, Open-Valley Underlayment: Install two layers of minimum 36-inch- wide underlayment centered in valley. Stagger end laps between layers at least 72 inches. Lap ends of each layer at least 12 inches in direction to shed water, and seal with asphalt roofing cement. Fasten each layer to roof deck.
1. Lap roof-deck underlayment over first layer of valley underlayment at least 6 inches.

3.3 METAL FLASHING INSTALLATION

- A. General: Install metal flashings and other sheet metal to comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
1. Install metal flashings according to recommendations in ARMA's "Residential Asphalt Roofing Manual" and NRCA's "NRCA Guidelines for Asphalt Shingle Roof Systems."
- B. Apron Flashings: Extend lower flange over and beyond each side of downslope asphalt shingles and up the vertical surface.
- C. Open-Valley Flashings: Install centered in valleys, lapping ends at least 8 inches in direction to shed water. Fasten upper end of each length to roof deck beneath overlap.
1. Secure hemmed flange edges into metal cleats spaced 12 inches apart and fastened to roof deck.
 2. Adhere 9-inch- wide strip of self-adhering sheet to metal flanges and to self-adhering sheet underlayment.

- D. Eave Drip Edges: Install eave drip-edge flashings below underlayment and fasten to roof sheathing.

3.4 ASPHALT-SHINGLE INSTALLATION

- A. General: Install asphalt shingles according to manufacturer's written instructions, recommendations in ARMA's "Residential Asphalt Roofing Manual," and recommendations in NRCA's "NRCA Guidelines for Asphalt Shingle Roof Systems."
- B. Install starter strip along lowest roof edge, consisting of an asphalt-shingle strip at least 7 inches wide with self-sealing strip face up at roof edge.
 - 1. Extend asphalt shingles 3/4 inch over fasciae at eaves and rakes.
 - 2. Install starter strip along rake edge.
- C. Install first and remaining courses of asphalt shingles stair-stepping diagonally across roof deck with manufacturer's recommended offset pattern at succeeding courses, maintaining uniform exposure.
- D. Fasten asphalt-shingle strips with a minimum of five roofing nails located according to manufacturer's written instructions.
 - 1. When ambient temperature during installation is below 50 deg F, seal asphalt shingles with asphalt roofing cement spots.
- E. Open Valleys: Cut and fit asphalt shingles at open valleys, trimming upper concealed corners of shingle strips. Maintain uniform width of exposed open valley from highest to lowest point.
 - 1. Set valley edge of asphalt shingles in a 3-inch- wide bed of asphalt roofing cement.
 - 2. Do not nail asphalt shingles to metal open-valley flashings.
- F. Hip and Ridge Shingles: Maintain same exposure of cap shingles as roofing shingle exposure. Lap cap shingles at ridges to shed water away from direction of prevailing winds. Fasten with roofing nails of sufficient length to penetrate sheathing.

END OF SECTION 073113

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Penetrations in fire-resistance-rated walls.
- B. Related Sections:
 - 1. Divisions 21 through 28 for mechanical, electrical, plumbing and fire protection penetrations requiring firestopping.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. 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. Qualification Data: For qualified Installer.
- B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.
- B. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:
 - 1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:
 - a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.

- b. Classification markings on penetration firestopping correspond to designations listed by the following:
 - 1) UL in its "Fire Resistance Directory."

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.6 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

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:
 - 1. Hilti, Inc.
 - 2. 3M Fire Protection Products.

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: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
 - 1. Fire-resistance-rated walls include fire walls fire-barrier walls and fire partitions.
 - 2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. 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.
- D. 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.

- E. 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.

2.3 FILL MATERIALS

- A. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- B. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- C. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.
- D. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
- E. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- F. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- G. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
- H. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

2.4 MIXING

- A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- 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. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

- A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. 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.
- C. 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.

3.4 IDENTIFICATION

- A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches 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.

3.5 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

END OF SECTION

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SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Non-load-bearing steel framing systems for interior partitions.
 - 2. Suspension systems for interior ceilings and soffits.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.
- B. Horizontal Deflection: For wall assemblies, limited to 1/240 of the wall height based on horizontal loading of 5 lbf/sq. ft..

2.2 FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C754 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C645 requirements for metal unless otherwise indicated.
 - 2. Protective Coating: ASTM AASTM A 653/A 653M, G40, hot-dip galvanized unless otherwise indicated.
 - 3. Protective Coating for Framing Members within Roof, Exterior Walls and Exterior Soffits: ASTM AASTM A 653/A 653M, G60, hot-dip galvanized unless otherwise indicated.
- B. Studs and Runners: ASTM C645. Use either steel studs and runners or embossed steel studs and runners.
 - 1. Steel Studs and Runners or Embossed Steel Studs and Runners:
 - 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) CEMCO; California Expanded Metal Products Co.
 - 2) ClarkDietrich Building Systems
 - 3) Marino WARE
 - 4) MBA Building Supplies.
 - 5) MRI Steel Framing, LLC.

- 6) USG Corporation
 - b. Minimum Base-Metal Thickness: As required by performance requirements for horizontal deflection but no less than indicated on Drawings.
 - c. Depth: As indicated on Drawings.
- C. Slip-Type Head Joints: Where indicated, provide one of the following:
 1. Single Long-Leg Runner System: ASTM C645 top runner with 2-inch- deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
 2. Double-Runner System: ASTM C645 top runners, inside runner with 2-inch- deep flanges in thickness not less than indicated for studs 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 applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) CEMCO; California Expanded Metal Products Co.; CST SLP-TRK Slotted Deflection Track.
 - 2) ClarkDietrich Building Systems; SLP-TRK Slotted Deflection Track.
 - 3) Superior Metal Trim; SFT
- D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
 1. Minimum Base-Metal Thickness: 0.0329 inch.
- E. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-metal thickness, with minimum 1/2-inch- wide flanges.
 1. Depth: As indicated on Drawings but not less than 1-1/2 inches.
 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.
- F. Hat-Shaped, Rigid Furring Channels: ASTM C645.
 1. Minimum Base-Metal Thickness: 0.0329 inch.
 2. Depth: As indicated on Drawings.
- G. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch- wide flanges.
 1. Depth: As indicated on Drawings.
 2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch.
 3. Tie Wire: ASTM A641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.
- H. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-metal thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.

2.3 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.
- B. Wire Hangers: ASTM A641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.
- C. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch and minimum 1/2-inch- wide flanges.
 - 1. Depth: 1-1/2 inches unless indicated otherwise.
- D. Furring Channels (Furring Members):
 - 1. Cold-Rolled Channels: 0.0538-inch uncoated-steel thickness, with minimum 1/2-inch- wide flanges, 3/4 inch deep.
 - 2. Steel Studs and Runners: ASTM C 645.
 - a. Minimum Base-Metal Thickness: 0.0329 inch.
 - b. Depth: 1-5/8 inches unless indicated otherwise.
 - 3. Embossed Steel Studs and Runners: ASTM C645.
 - a. Minimum Base-Metal Thickness: 0.0190 inch.
 - b. Depth: 1-5/8 inches unless otherwise indicated.
 - 4. Hat-Shaped, Rigid Furring Channels: ASTM C645, 7/8 inch deep.
 - a. Minimum Base-Metal Thickness: 0.0329 inch.
- E. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Armstrong World Industries, Inc; Drywall Grid Systems.
 - b. Chicago Metallic Corporation; SpanFast Drywall Ceiling Suspension Systems.
 - c. United State Gypsum Company; Drywall Suspension System.

2.4 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 - 1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide one of the following:
 - 1. Asphalt-Saturated Organic Felt: ASTM D 226/D 226M, Type I (No. 15 asphalt felt), nonperforated.
 - 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

3.3 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 framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 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.
 - 1. Single-Layer Application: 16 inches o.c. unless otherwise indicated.
 - 2. Multilayer Application: 16 inches o.c. unless otherwise indicated.
 - 3. Tile Backing Panels: [As required by horizontal deflection performance requirements] [16 inches o.c.] unless otherwise indicated.
- 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 that penetrate 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 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.
- E. Z-Shaped Furring Members:
1. Erect insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced 24 inches o.c. unless otherwise indicated .
 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 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 from corner and cut insulation to fit.
- F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.5 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.
1. Hangers: 48 inches o.c.
 2. Carrying Channels (Main Runners): 48 inches o.c.
 3. Furring Channels (Furring Members): 16 inches o.c.
- 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 required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
4. Do not attach hangers to steel roof deck.
5. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
6. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
7. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- F. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Interior gypsum board.
 - 2. Metal trim and accessories.
- B. Related Requirements:
 - 1. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.3 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.4 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

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.

2.2 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Georgia-Pacific Gypsum LLC.
 - 2. Lafarge North America Inc.
 - 3. National Gypsum Company.
 - 4. USG Corporation.
- B. Gypsum Wallboard: ASTM C1396/C 1396M.
 - 1. Thickness: 5/8 inch.
 - 2. Long Edges: Tapered.
- C. Gypsum Board, Type X: ASTM C 1396/C 1396M.
 - 1. Thickness: 5/8 inch.
 - 2. Long Edges: Tapered.
- D. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
 - 1. Thickness: 1/2 inch.
 - 2. Long Edges: Tapered.
- E. Abuse-Resistant Gypsum Board: ASTM C 1396/C 1396M gypsum board, tested according to ASTM C 1629/C 1629M.
 - 1. Core: 5/8 inch, Type X.
 - 2. Surface Abrasion: ASTM C1629/C 1629M, meets or exceeds Level 2 requirements.
 - 3. Indentation: ASTM C1629/C 1629M, meets or exceeds Level 2 requirements.
 - 4. Soft-Body Impact: ASTM C1629/C 1629M, meets or exceeds Level 2 requirements.
 - 5. Long Edges: Tapered.

2.4 TRIM ACCESSORIES

- A. Interior Trim: ASTM C1047.
 - 1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
 - 2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. L-Bead: L-shaped; exposed long flange receives joint compound.
 - d. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - e. Expansion (control) joint. Maximum 30 feet o.c.

2.5 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C475/C 475M.
- B. Joint Tape:
 - 1. Interior Gypsum Board: Paper.
- 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.
 - 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 - 3. Fill Coat: For second coat, use setting-type, sandable topping compound.
 - 4. Finish Coat: For third coat, use drying-type, all-purpose compound.

2.6 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
 - 1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- 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.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 - 1. Type X: As indicated on Drawings.
 - 2. Abuse-Resistant Type: On exposed surfaces of walls.
- B. Single-Layer Application:
 - 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
 - 2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
 - 3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- C. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.

3.4 INSTALLING TRIM ACCESSORIES

- A. General: For 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.
- B. Control Joints: Install control joints according to ASTM CASTM C 840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
 1. Cornerbead: Use at outside corners unless otherwise indicated.
 2. LC-Bead: Use at exposed panel edges.
 3. L-Bead: Use where indicated.
 4. U-Bead: Use where indicated.

3.5 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. 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 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in Division 09 Section "Painting."

3.6 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes acoustical panels and exposed suspension systems for interior ceilings.
- B. Related Requirements:
- C. Division 09 Section "Non-Structural Metal Framing for suspension systems for gypsum board ceilings.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:
 - 1. Acoustical Panels: Set of 6-inch- square Samples of each type, color, pattern, and texture.
 - 2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch-long Samples of each type, finish, and color.

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:
 - 1. Ceiling suspension-system members.
 - 2. Structural members to which suspension systems will be attached.
 - 3. Size and location of initial access modules for acoustical panels.
 - 4. Items penetrating finished ceiling and ceiling-mounted items including the following:
 - a. Lighting fixtures.
 - b. Diffusers.
 - c. Grilles.
 - d. Speakers.
 - e. Access panels.
 - f. Perimeter moldings.
 - 5. Minimum Drawing Scale: 1/8 inch = 1 foot.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Acoustical Ceiling Units: Full-size panels in full cartons equal to 20 tiles minimum.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Class A according to ASTM E1264.
 - 2. Smoke-Developed Index: 50 or less.

2.3 ACOUSTICAL PANELS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries; School Zone Fine Fissured High NRC/High CAC (no. 1717) or comparable product by one of the following:
 - 1. CertainTeed Corporation.
 - 2. United States Gypsum Company.
- B. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.
- C. Classification: Provide panels as follows:
 - 1. Type and Form: Type III, mineral base with painted finish; Form 2, water felted.
 - 2. Pattern: CE (perforated, small holes and lightly textured) .

- D. Color: White.
- E. Light Reflectance (LR): Not less than 0.85.
- F. Ceiling Attenuation Class (CAC): Not less than 40.
- G. Noise Reduction Coefficient (NRC): Not less than 0.70.
- H. Edge/Joint Detail: Reveal sized to fit flange of exposed suspension-system members.
- I. Thickness: 3/4 inch.
- J. Modular Size: 24 by 24 inches.

2.4 METAL SUSPENSION SYSTEM

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries;Suprafine XL 9/16" Exposed Tee or comparable product by one of the following:
 - 1. CertainTeed Corporation.
 - 2. United States Gypsum Company.
- B. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C 635/C 635M and designated by type, structural classification, and finish indicated.
- C. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation; with prefinished 9/16-inch- wide metal caps on flanges.
 - 1. Structural Classification: Intermediate or Heavy-duty system as determined by suspension system manufacturer based on loading.
 - 2. Face Design: Flat, flush.
 - 3. Cap Material: Cold-rolled steel.
 - 4. Cap Finish: Painted white .

2.5 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
- B. Wire Hangers, Braces, and Ties: Provide wires as follows:
 - 1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A 641M, Class 1 zinc coating, soft temper.
 - 2. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM CASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than 0.106-inch- diameter wire.
- C. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch- thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 coating designation; with bolted connections and 5/16-inch- diameter bolts.
- D. Hold-Down Clips: Manufacturer's standard hold-down.

2.6 METAL EDGE MOLDINGS AND TRIM

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries or comparable product by one of the following:
 - 1. CertainTeed Corporation.
 - 2. United States Gypsum Company.
- B. 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. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

- A. Install acoustical panel ceilings according to ASTM C636/C 636M, manufacturer's written instructions, and CISCA's "Ceiling Systems Handbook".
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with 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.
 4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure 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.
 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 8. Do not attach hangers to steel deck tabs.
 9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
 11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
- C. 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 postinstalled anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends. Miter corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. 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 precise fit.
1. Arrange directionally patterned acoustical panels as follows:
 - a. As indicated on reflected ceiling plans.
 2. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.

3. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

3.4 ERECTION TOLERANCES

- A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet, non-cumulative.
- B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet, non-cumulative.

3.5 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.
- B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Resilient base.
 - 2. Resilient molding accessories.
- B. Related Sections:
 - 1. Division 09 Section "Resilient Tile Flooring."
 - 2. Division 09 Section "Tile Carpeting."

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches long.
- C. Samples for Initial Selection: For each type of product indicated.
- D. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches long.

1.3 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. Furnish in full cartons not less than 15 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.5 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.

- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC-RUBBER BASE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armstrong World Industries, Inc.
 - 2. Flexco.
 - 3. Johnsonite; A Tarkett Company.
 - 4. Mondo Rubber International, Inc.
 - 5. Roppe Corporation, USA.
- B. Product Standard: ASTM F 1861, Type TP (rubber, thermoplastic).
 - 1. Group: I (solid, homogeneous).
 - 2. Style and Location:
 - a. Style A, Straight: Provide in areas with carpet.
 - b. Style B, Cove: Provide in areas with resilient flooring.
- C. Thickness: 0.125 inch.
- D. Height: 4 inches.
- E. Lengths: Coils in manufacturer's standard length.
- F. Outside Corners: Job formed or preformed.
- G. Inside Corners: Job formed or preformed.
- H. Colors: As selected by Architect from full range of industry colors.

2.2 RUBBER MOLDING ACCESSORY

- A. Description: Rubber carpet edge for glue-down applications reducer strip for resilient flooring joiner for tile and carpet and transition strips.
- B. Locations: Provide rubber molding accessories where required to protect floor finish edges where no other transitions are provided by other Sections..
- C. Colors and Patterns: As selected by Architect from full range of industry colors.

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.
 - 1. Adhesives shall have a VOC content of 50 g/L or less.
- C. Metal Edge Strips: Extruded aluminum with mill finish of width shown, of height required to protect exposed edges of flooring, and in maximum available lengths to minimize running joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until they are the same temperature as the space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

- E. Do not stretch resilient base during installation.
- F. Preformed Corners: Install preformed corners before installing straight pieces.
- G. Job-Formed Corners:
 - 1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
 - a. Form without producing discoloration (whitening) at bends.
 - 2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.

3.4 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
 - 1. Remove adhesive and other blemishes from exposed surfaces.
 - 2. Sweep and vacuum horizontal surfaces thoroughly.
 - 3. Damp-mop horizontal surfaces to remove marks and soil.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION

SECTION 096519 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Vinyl composition floor tile.
- B. Related Sections:
 - 1. Division 09 Section "Resilient Base."
 - 2. Division 09 Section "Tile Carpeting."

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Initial Selection: For each type of floor tile indicated.
- C. Samples for Verification: Full-size units of each color and pattern of floor tile required.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.
 - 1. Engage an installer who employs workers for this Project who are trained or certified by floor tile manufacturer for installation techniques required.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store floor tiles on flat surfaces.

1.6 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor tile during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.

- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during floor tile installation.
- D. Close spaces to traffic for 48 hours after floor tile installation.
- E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient tile flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 VINYL COMPOSITION FLOOR TILE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries; Standard Excelonor comparable product by one of the following:
 - 1. Johnsonite/Tarkett Group.
 - 2. Mannington Mills, Inc.
- B. Tile Standard: ASTM F 1066 Class 2, through-pattern .
- C. Wearing Surface: Smooth.
- D. Thickness: 0.125 inch.
- E. Size: 12 by 12 inches.
- F. Colors and Patterns:
 - 1. Field color: As selected by Architect from full range of industry colors.

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
 - 1. Adhesives shall comply with the following limits for VOC content:
 - a. Vinyl Composition Tile Adhesives: 50 g/L or less.
- C. Floor Polish: Provide protective, liquid floor-polish products recommended by floor tile manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F 710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing.
 - 4. Moisture Testing: Proceed with installation only after substrates pass testing according to floor tile manufacturer's written recommendations, but not less stringent than the following:
 - a. Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
 - b. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floor tiles until they are the same temperature as the space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.3 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

1. Lay tiles square with room axis.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
 1. Lay tiles with grain direction alternating in adjacent tiles (basket-weave pattern) and in pattern of colors and sizes indicated.
- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in finished floor areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.
- H. Adhere floor tiles to flooring 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.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
 1. Remove adhesive and other blemishes from exposed surfaces.
 2. Sweep and vacuum surfaces thoroughly.
 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, adhesive, and blemishes from floor tile surfaces before applying liquid floor polish.
- E. Cover floor tile until Substantial Completion.

END OF SECTION

SECTION 096813 - TILE CARPETING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes modular carpet tile.
- B. Related Requirements:
 - 1. Section 096513 "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
 - 2. Include manufacturer's written installation recommendations for each type of substrate.
- B. Samples: 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.
- C. Samples for Initial Selection: For each type of carpet tile.
- D. 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.
 - 1. Carpet Tile: Full-size Sample.

1.3 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. 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.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, 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..

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI's "CRI Carpet Installation Standard."

1.8 FIELD CONDITIONS

- A. Comply with CRI's "CRI Carpet Installation Standard" for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.
- 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.

1.9 WARRANTY

- A. Special Warranty for Carpet Tiles: 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, the following:
 - a. More than 10 percent edge raveling, snags, and runs.
 - b. Dimensional instability.
 - c. Excess static discharge.
 - d. Loss of tuft-bind strength.
 - e. Loss of face fiber.
 - f. Delamination.
 - 3. Warranty Period: 10 years from date of Substantial Completion..

PART 2 - PRODUCTS

2.1 CARPET TILE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Shaw Contract Group; Expose Tile in Vertical Layers Collection or comparable product by one of the following:
 - 1. Interface, LLC.
- B. Color: As selected by Architect from manufacturer's full range.
- C. Fiber Content: 100 percent nylon 6, 6.

- D. Density: 6085 oz./cu. yd.
- E. Pile Thickness: 0.142 inches for finished carpet tile according to ASTM D6859.
- F. Stitches: 9 stiches per inch.
- G. Gage: 1/12 .
- H. Total Weight: 24 oz./sq. yd. for finished carpet tile.
- I. Primary Backing/Backcoating: Manufacturer's standard composite materials .
- J. Secondary Backing: Manufacturer's standard material.
- K. Size: 9 by 36 inches.
- L. Applied Treatments:
 - 1. Soil-Resistance Treatment: Manufacturer's standard treatment.

2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.
 - 1. VOC Content: 50 g/L or less.

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.
- B. Examine carpet tile for type, color, pattern, and potential defects.
- C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.
 - 1. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. 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. in 24 hours.
 - b. Relative Humidity Test: Using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
 - c. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.

- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with CRI's "CRI Carpet Installation Standards" and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.
- 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 wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.
- C. Concrete Substrates: 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 adhesive and carpet tile manufacturers.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

- A. General: Comply with CRI's "CRI Carpet Installation Standard," Section 18, "Modular Carpet" 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. Maintain pile-direction patterns :
- E. Pattern: Ashlar.
- F. 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.
- G. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- H. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.
- I. Install pattern parallel to walls and borders. Verify orientation of pattern with Architect prior to installation.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet tile surface.
 - 3. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile to comply with CRI's "CRI Carpet Installation Standard," Section 20, "Protecting 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

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SECTION 099123 – PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following interior and exterior substrates as scheduled in the Room Finish Schedule and shown in the Drawings:
 - 1. CMU.
 - 2. Steel.
 - 3. Gypsum board.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Step coats on Samples to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- C. Product List: For each product indicated, include the following:
 - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
 - 2. VOC content.

1.3 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each interior paint system specified in Part 3.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 50 sq. ft..
 - b. Other Items: Architect will designate items or areas required.
 - 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

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.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 1. Maintain containers in clean condition, free of foreign materials and residue.
 2. Remove rags and waste from storage areas daily.

1.5 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
- C. Do not paint over UL, FMG or other code-required labels or equipment name, identification, performance rating or nomenclature plates.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Products listed in the Schedules are from PPG Paints.
- B. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Benjamin Moore & Co.
 2. PPG Paints.
 3. Pratt & Lambert Paints
 4. Sherwin-Williams Company (The).

2.2 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. Material Quality: Provide manufacturer's factory formulated best-quality paint materials of coating types specified. Paint material containers not displaying manufacturer's product identification will not be acceptable.

1. VOC Content: Products shall comply with the lower VOC limit specified in OBBC or other authorities having jurisdiction.
- C. Colors: As selected by Architect from manufacturer's full range.

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 the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 1. Gypsum Board: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- E. Proceed with coating application only after unsatisfactory conditions have been corrected.
 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Cementitious Materials: Prepare concrete surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.
- E. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
 1. SSPC-SP 2, "Hand Tool Cleaning."
 2. SSPC-SP 3, "Power Tool Cleaning."

- F. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- G. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. 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.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 - 1. Paint the following work where exposed in occupied spaces and as scheduled:
 - a. Equipment, including panelboards.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Ductwork and hangers.
 - h. Diffusers, grilles and registers not matching exposed ceiling color.
 - i. Other visible equipment including pipe insulation having a paintable jacket material.
 - j. Metal decking and steel framing.

- k. Floating ceiling suspension systems.
 - l. Access doors and frames.
 - m. Other items as directed by Architect.
2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
- 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. 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.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

- A. Ferrous Metal Surfaces – 3-Coat Latex System, Semi-Gloss Finish:
- 1. Primer: Reference Division 5 Sections.
 - 2. Spot Primer: Direct to metal acrylic emulsion waterborne primer / finish.
 - a. Product: Pitt Tech Plus 90-912 DTM Primer Finish. 3 -4 mils DFT / coat
 - 3. (2) Finish Coats: DTM Water based Finish.
 - a. Product: PittTech Plus 90-1210 DTM Semi-Gloss Finish. 3 -4 mils DFT / coat.
 - 4. Surfaces: As scheduled and including but not limited to structural steel, hollow metal door frames and miscellaneous steel.
- B. CMU Wall Surfaces - 3-Coat latex Acrylic, Eggshell Finish:
- 1. Block filler: 6-7 SpeedHide Interior/Exterior Masonry Latex Block Filler, 6 - 12.5 mils DFT.
 - 2. (2) Finish Coats: 6-4310XI SpeedHide Interior Zero VOC Eggshell Latex, 1.4 mils DFT / coat.
- C. Gypsum Board Ceiling Surfaces - 3-Coat Latex Acrylic, Flat Finish:

1. Primer: High build drywall surfacer, spray application
 - a. Product: Speedhide 6-1 MaxBuild High Build Surfacer, 7 - 9 mils DFT / coat.
 2. (2) Finish Coats: Low-Odor/VOC Latex.
 - a. Product: Speedhide 6-4110 Zero VOC Interior Flat latex 1.3 mils DFT / coat.
 3. Surfaces: Gypsum board ceiling surfaces.
- D. Gypsum Board Wall Surfaces - 3-Coat Latex Acrylic, Eggshell Finish:
1. Primer: High build drywall surfacer, spray application.
 - a. Product: Speedhide 6-1 MaxBuild High Build Surfacer, 7 - 9 mils DFT / coat.
 2. (2) Finish Coats: Institutional Low-Odor/VOC Latex.
 - a. Product: Speedhide 6-4310 Zero VOC Interior Eggshell latex 1.4 mils DFT / coat.
 3. Surfaces: Gypsum board wall surfaces subject to moderate abuse.
- E. Gypsum Board Wall Surfaces - 3-Coat Acrylic Epoxy, Semi-Gloss Finish:
1. Primer: High build drywall surfacer, spray application.
 - a. Product: Speedhide 6-1 MaxBuild High Build Surfacer, 7 - 9 mils DFT / coat.
 2. (2) Finish Coats: High performance pre catalyzed water based epoxy.
 - a. Product: Pittglaze 16-510 Pre CatalyzedAcrylic Epoxy Semi-Gloss. 2 -3 mils DFT / coat.
 3. Surfaces: Gypsum board wall surfaces in mechanical service areas and other areas as directed.
- F. Ferrous Metal Elevator Doors and Frames – Field-applied Electrostatic Coating System:
1. Two component catalyzed epoxy enamel specifically designed for on-site electrostatic application.

3.7 EXTERIOR PAINT SCHEDULE

- A. Galvanized Metal - 3 Coat Acrylic System, Semi-Gloss Finish:
1. Primer: Allow new galvanized surfaces to weather six months min or treat with Galvaprep solution, or similar treatment, per manufacturer's directions prior to primer application.
 - a. Product: Pitt Tech Plus 90-912 DTM Primer Finish. 3 -4 mils DFT / coat.
 2. (2) Finish Coats:
 - a. Product: PittTech Plus 90-1210 DTM Semi-Gloss Finish. 3 -4 mils DFT / coat.
 3. Surfaces: Exterior galvanized surfaces and other misc. exterior steel indicated to be painted.

END OF SECTION

SECTION 101423 - PANEL SIGNAGE

PART 2 - GENERAL

2.1 SUMMARY

- A. Section Includes:
 - 1. Directional signs.
 - 2. Room-identification signs, including signs with cork messaging panels.

2.2 DEFINITIONS

- A. Accessible: In accordance with the accessibility standard.

2.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Show message list, timesteps, graphic elements, including raised characters and Braille, and layout for each sign at least half size.
- C. Sign Schedule: Use same designations specified or indicated on Drawings or in a sign schedule.

2.4 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

PART 3 - PRODUCTS

3.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for signs.

3.2 SIGNS

- 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 product indicated or comparable product by one of the following:
 - 1. ASI Sign Systems, Inc.
 - 2. Size: As indicated.
- C. Interior Signs : Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

1. Basis-of-Design Product: ASI Sign Systems, Inc.; InTouch ADA-Ready Sign System.
2. Laminated-Sheet Sign: Photopolymer face sheet with raised graphics laminated over subsurface graphics to acrylic backing sheet to produce composite sheet.
 - a. Color(s): As selected by Architect from manufacturer's full range.
3. Sign-Panel Perimeter: Finish edges smooth.
 - a. Edge Condition: Beveled.
 - b. Corner Condition in Elevation: As indicated.
4. Frame for cork panel: Aluminum.
 - a. Profile: Square.
 - b. Corner Condition in Elevation: Square.
 - c. Finish and Color: As selected by Architect from manufacturer's full range.
5. Mounting: Surface mounted to wall with adhesive and two-face tape .

3.3 PANEL-SIGN MATERIALS

- A. Acrylic Sheet: ASTM D 4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).

3.4 ACCESSORIES

- A. Adhesives: As recommended by sign manufacturer and with a VOC content of 70 g/L or less for adhesives used inside the weatherproofing system and applied on-site when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.

3.5 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.

3.6 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. 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.
- C. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

3.7 ALUMINUM FINISHES

- A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 4 - EXECUTION

4.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of signage work.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

4.2 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
 - 3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
 - 4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Room-Identification Signs and Other Accessible Signage: Install in locations on walls as indicated and according to accessibility standard.
- C. Mounting Methods:
 - 1. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
 - 2. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.

4.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101423

SECTION 123661.16 - SOLID SURFACING COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes solid surface material in restrooms for:
 - 1. Countertops and backsplashes.

1.2 ACTION SUBMITTALS

- A. Product Data: For countertop materials and sinks.
- B. Shop Drawings: For countertops and sinks. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
- C. Samples: For each type of material exposed to view.

PART 2 - PRODUCTS

2.1 SOLID SURFACE COUNTERTOP MATERIALS

- A. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Avonite Surfaces.
 - 2. E. I. du Pont de Nemours and Company (Basis of design).
 - 3. Formica Corporation.
 - 4. LG Chemical, Ltd.
 - 5. Wilsonart LLC.
- C. Type: Provide Standard type unless Special Purpose type is indicated.
- D. Colors and Patterns: As selected by Architect from manufacturer's full range.
- E. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch-sanded.

2.2 COUNTERTOP FABRICATION

- A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WT's "Architectural Woodwork Standards."
 - 1. Grade: Custom.
- B. Configuration:

1. Front: Straight, slightly eased at top.
 2. Backsplash: Straight, slightly eased at corner.
- C. Countertops: 3/4-inch-thick, solid surface material with front edge built up with same material.
- D. Backsplashes: 1/2-inch-thick, solid surface material.
- E. Joints: Fabricate countertops without joints.
- F. Cutouts and Holes:
1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.

2.3 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by solid surface material manufacturer.
1. Adhesives shall have a VOC content of 70 g/L or less.

PART 3 - EXECUTION

3.1 DELIVERY AND PROTECTION

- A. Provide protection of countertop and sink assembly. Transport assembly to jobsite in cutout carrier to provide support and protection during transportation and installation.

3.2 INSTALLATION

- A. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Pre-drill holes for screws as recommended by manufacturer.
- B. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
- C. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions.
- D. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
- E. Install backsplashes and end splashes by adhering to wall and countertops with adhesive.
- F. Install aprons to backing and countertops with adhesive.
- G. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
- H. Apply sealant to gaps at walls.

END OF SECTION

SECTION 126100 - FURNISHINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes:
 - 1. Interior furniture.
 - 2. Transportation, delivery, assembly, and final placement.
 - 3. Off-site warehousing.
- B. Bidding and Contract requirements:
 - 1. Refer to bidding and contract administration requirements in documents listed in Table of Contents in the Project Manual.
 - 2. Base costs for orders placed within or after bid holding period upon costs in effect at time of ordering; subsequent price increases will not be paid by Owner or Architect.
 - 3. Project will be installed in one phase. See scope of work summary.
- C. Quantities:
 - 1. Bidder is responsible to verify quantity take-offs from the drawings and specifications provided. Location codes and quantities are provided to assist in locating items only. If a quantity discrepancy is found between the specifications and the drawings, the higher quantity shall prevail.
- D. Finishes:
 - 1. After award of contract, Architect will select finishes based on those submitted.
 - 2. Finishes will be manufacturers standard, or as noted.
- E. Warranties: Minimum 10-year warranty on all furniture.

1.3 SUBMITTALS

- A. Reference Division 1 Section "Submittal Procedures".
- B. General: All paper-type submittals to be in the form of PDF's..
- C. Submit items indicated below to Architect.
 - 1. Manufacturer's PDF's of product literature and entire retail price list per each specified item.
 - a. Include cleaning, stain removal methods and recommended cleaning materials, polishes and waxes.
 - b. Include maintenance instructions and parts lists.
 - c. Include warranty information and/or certificates.
 - 2. Three actual finish samples of each finish and upholstery to be specified or selected by Architect.
 - 3. PDF's of shop drawings for special and custom items for review by Architect.
 - 4. Copies of manufacturer's order acknowledgments within twenty (20) days after contract award.
 - 5. Substitution submittals:

- a. Information assembled to support proposed “substitution” shall be submitted in duplicate for use by Owner and Architect.
 - b. Prepare a Schedule and Specification sheet accurately identifying each product proposed for “substitution”.
 - c. Use the “Substitution Request Form”. Reference Division 1 Section “Product Requirements”.
6. Operation and Maintenance Data in the form of hardcopies in binders as specified in Division 1 Section “Operation and Maintenance Data.”

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. Where sizes of “substitutions” are not identical to those specified, it must be so noted in Bid. Size differences may be acceptable provided that Bidder can demonstrate complete dimensional compatibility with other related products and construction.
- B. Where other manufacturers’ products are quoted as “substitutions” perform below the standard specifications, or are not available, such deviation must be so noted in Bid. Architect may require special fabrications to equal or exceed the standard. Costs of same must be quoted prior to contract awards.
 1. Where specific finish requirements are noted (i.e. color stain) and where this is not a substituted manufacturers’ standard, include any up-charges for this option.

2.2 MANUFACTURERS AND PRODUCTS

- A. See appendix following this Section.

2.3 ADDITIONAL SERVICES

- A. Warehousing beyond specified time in Part 1 herein:
 1. Cost by cubic foot, square foot, weight or other means of measure.
 2. Pro-rate in fourteen day increments.
- B. Additional labor rates per hour for adjustments and moving items beyond that specified, as requested by Owner or Architect.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Verify that areas or rooms are ready to accept furnishings.
- B. Protect areas surrounding this work from damage.

3.2 INSTALLATION

- A. Assemble items per manufacturers’ instructions.
- B. Place items as indicated on Drawings.
- C. Level items after placement.

3.3 ADJUSTMENT AND CLEANING

- A. Remove tags and labels from furniture and furnishings.
- B. Clean dust, dirt, grease and adhesives from items; clip loose threads if non-injurious to fabric. Do not pull threads.

- C. Remove shipping cartons, packing materials and other related installation debris from job site. Leave area in occupiable condition.
- D. Repair or replace scratched, dented, nicked, warped, bent, discolored, or incorrectly colored or finished surfaces or items. Repair or replace non-functioning parts or items. Replace entire item when the sum of the parts replaced exceeds the original amount of the item as specified, as determined by the Owner or Architect.
- E. Repair or replace finish surfaces or items of building construction soiled or damaged by work specified herein. Match adjacent material, surfaces or items.

3.4 TEMPORARY FURNITURE

- A. Temporary furniture equal in function to specified item shall be loaned at no cost to Owner for items:
 - 1. Not delivered as per original acknowledgement due to no fault of Owner or Architect.
 - 2. Found by Owner or Architect to be unusable and requiring replacement.
 - 3. Requiring removal from site for repair.




3.5 APPENDICES

- A. The following are considered part of this specification section:
 - 1. Appendix A: "Furnishings Specifications".




END OF SECTION

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Furnishings Specifications

TAG	MFR.	DESCRIPTION	QUANTITY	PHOTO
S1	SitOnIt	<p>Armless Side Chair Lumin, model no. 1011-FT1 US A0 CL13</p> <p>Stacking armless side chair, molded back, upholstered seat, carpet casters.</p> <p>Frame color: To be selected from mfr's. full range Back/seat color: To be selected from mfr's. full range Upholstery: Maharam "Messenger" treated with Nano-tex / Durablock. Color(s) to be selected from Maharam's full range.</p>	20	
S1A	SitOnIt	<p>Side Chair with Arms Same as item S1 above except with arms</p>	48	
S2	National Office	<p>Armless, Mobile Lounge Chair Swift, model no. N95MAC</p> <p>Base finish: Polished aluminum Trim color: "Cinder" Upholstery: Maharam "Messenger" treated with Nano-tex / Durablock. Color(s) to be selected from Maharam's full range. Casters: black, double-wheeled roll control castors for hard or soft flooring</p>	10	
S2A	National Office	<p>Mobile Lounge Chair with Arms Swift, model no. N95AAC</p> <p>Base finish: Polished aluminum Trim color: "Cinder" Upholstery: Maharam "Messenger" treated with Nano-tex / Durablock. Color(s) to be selected from Maharam's full range. Casters: black, double-wheeled roll control castors for hard or soft flooring</p>	12	



Furnishings Specifications

TAG	MFR.	DESCRIPTION	QUANTITY	PHOTO
S3	National Office	<p>Modular 90 def. Sofa Corner Unit Swift, model no. N95MK</p> <p>Base/leg finish: Polished aluminum Trim color: "Cinder" Upholstery: Maharam "Messenger" treated with Nano-tex / Durablock. Color(s) to be selected from Maharam's full range.</p> <p>Provide ganging kit</p>	2	
S3L	National Office	<p>Modular 3-seat Sofa Left Arm Unit Swift, model no. N95MCL</p> <p>Base/leg finish: Polished aluminum Trim color: "Cinder" Upholstery: Maharam "Messenger" treated with Nano-tex / Durablock. Color(s) to be selected from Maharam's full range.</p> <p>Provide ganging kit</p>	1	 Similar: left-hand unit
S3R	National Office	<p>Modular 3-seat Sofa Right Arm Unit Swift, model no. N95MCR</p> <p>Base/leg finish: Polished aluminum Trim color: "Cinder" Upholstery: Maharam "Messenger" treated with Nano-tex / Durablock. Color(s) to be selected from Maharam's full range.</p> <p>Provide ganging kit</p>	1	



Furnishings Specifications

TAG	MFR.	DESCRIPTION	QUANTITY	PHOTO
S4	National Office	<p>Armless 3-seat Sofa Swift, model no. N95MC</p> <p>Base/leg finish: Polished aluminum Trim color: "Cinder" Upholstery: Maharam "Messenger" treated with Nano-tex / Durablock. Color(s) to be selected from Maharam's full range.</p>	1	
S5L	National Office	<p>Modular 2-seat Sofa Left Arm Unit Swift, model no. N95MBL</p> <p>Base/leg finish: Polished aluminum Trim color: "Cinder" Upholstery: Maharam "Messenger" treated with Nano-tex / Durablock. Color(s) to be selected from Maharam's full range.</p> <p>Provide ganging kit</p>	1	 <p>Similar: left-hand unit</p>
S5R	National Office	<p>Modular 2-seat Sofa Right Arm Unit Swift, model no. N95MBR</p> <p>Base/leg finish: Polished aluminum Trim color: "Cinder" Upholstery: Maharam "Messenger" treated with Nano-tex / Durablock. Color(s) to be selected from Maharam's full range.</p> <p>Provide ganging kit</p>	1	

Furnishings Specifications

TAG	MFR.	DESCRIPTION	QUANTITY	PHOTO
S6	National Office	<p>Mobile Bench/Ottoman Swift, model no. N95DDC</p> <p>Base finish: Polished aluminum Trim color: "Cinder" Upholstery: Maharam "Messenger" treated with Nano-tex / Durablock. Color(s) to be selected from Maharam's full range.</p> <p>Casters: black, double-wheeled roll control castors for hard or soft flooring</p>	2	
T1	National Office	<p>Rectangular Activity Table Waveworks 36" wide x 48" long x 29" high</p> <p>4-seat, fixed-top, activity table with flat, molded pvc edge and mobile column legs (carpet casters.)</p> <p>Leg color: to be selected from mfr's. full range</p> <p>Top laminate: To be selected from mfr's. full range</p> <p>Top edge color: To be selected from mfr's. full range.</p> <p>Note 36" width</p>	14	
T2	National Office	<p>Rectangular Activity Table Same as item T1 except 60" long</p>	2	

Furnishings Specifications

TAG	MFR.	DESCRIPTION	QUANTITY	PHOTO
T3	National Office	<p>Occasional Table Swift, model no. N95PPL 14"w x 28"d x 16.5"h Laminate occasional table with solid surface top and metal legs</p> <p>Top color: To be selected from mfr's. full range</p> <p>Side laminate: To be selected from Base/leg finish: Polished aluminum</p> <p>Provide solid surface top kit</p>	4	 <p>Similar: solid surface top</p>
T4	National Office	<p>Occasional Table Swift, model no. N95NNL 28"w x 28"d x 16.5"h Laminate occasional table with solid surface top and metal legs</p> <p>Top color: To be selected from mfr's. full range</p> <p>Side laminate: To be selected from Base/leg finish: Polished aluminum</p> <p>Provide solid surface top kit</p>	3	 <p>Similar: solid surface top</p>

Note: Items listed constitute the basis of design. Other manufacturer or models may be considered.

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SECTION 220000 – PLUMBING WORK

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 a summary of all Plumbing related work.
- B. Related Sections:
 - 1. 220000 – Plumbing Work
 - 2. 220400 – General Plumbing Requirements
 - 3. 220500 – Common Work Results for Plumbing Work
 - 4. 220517 – Sleeves and Sleeve Seals for Plumbing Piping
 - 5. 220518 – Escutcheons for Plumbing Piping
 - 6. 220523 – General-Duty Valves for Plumbing Piping
 - 220529 – Hangers and Supports for Plumbing Piping and Equipment
 - 7. 220553 – Identification for Plumbing Piping and Equipment
 - 8. 220700 – Pipe Insulation
 - 9. 221116 – Domestic Water Piping
 - 10. 221316 – Sanitary Waste Vent System
 - 11. 221413 – Facility Storm Drainage Piping
 - 12. 221423 – Storm Sewer System
 - 13. 221424 – Natural Gas System
 - 14. 221425 – Facility Natural Gas Piping
 - 15. 221430 – Plumbing Specialties
 - 16. 224000 – Plumbing Fixtures

1.3 PROJECT CONDITIONS

- A. Alterations of and Additions to Existing Plumbing Systems
 - 1. The contract shall include the installation of the work as shown, specified, or required, and shall include the following principal components:
 - a. Furnish and install new secondary roof drains as shown including all necessary piping thereto.
 - b. Furnish and install plumbing fixtures.
 - c. Furnish and install natural gas piping.
 - d. Rework plumbing lines, in numerous locations for coordination with HVAC work.
 - e. Provide certain pipe insulation.
 - f. All work shall be performed in strict accordance with Greater Cincinnati Water Works rules, regulations, and drawings and the Plumbing Division of the Ohio Health Department.
 - g. Provide complete soil, waste, vent, and water piping for Plumbing Fixtures.

- h. Perform start-up for all plumbing systems and commission same in accordance with the commissioning requirement.
- i. Provide and/or participate in training of Owner's personnel on the use of all new plumbing systems.
- 2. The contractor shall exercise adequate protective and safety measures for all persons and property and shall be responsible for any damages or injuries arising from the execution of this work.
- 3. Alterations and additions to existing work shall include the requisite dismantling of the old equipment, rigging, wrecking, hauling, protections of permanent equipment and the building structures, and cleaning up. Care shall be exercised to keep dust and dirt to a minimum and to confine it to the area where the removal work is being performed. All debris shall be promptly removed.
- 4. If asbestos insulation is encountered on any existing piping which is to be removed or remodeled, contractor shall immediately notify Owner of the existence of asbestos and Owner will arrange proper removal of same without cost to contractor.
- 5. Unless otherwise noted, remove all other existing equipment and piping, valves, fittings, etc. which will not be reused in the final arrangement. Plug or cap openings in piping which will remain. Unless otherwise noted, all items which will be removed by this contractor and not reused shall become the property of the contractor and shall be promptly removed from the site by him.
- 6. The existing facility will be partially occupied and will remain in operation throughout the period that this work is being performed, and certain new work will be performed during this period. Unscheduled interruptions of the facility will not be tolerated. The contractor shall exercise extreme caution, shall thoroughly inform his workmen and subcontractors of the critical nature of this work, and shall continually review the work procedure being followed in order to prevent accidental interruption of service. Before performing any act which could result in interruption of service, the contractor shall notify the Owner and Engineer of the hazards involved and the contractor shall proceed in a manner and at a time specifically approved by the Owner and Engineer.
- 7. All work necessitating the temporary turning off or shutting down the operation of existing mechanical and/or electrical facilities shall be done at times specifically approved by the Owner and Engineer in advance of any disruption of existing facilities. Also, refer to Section 22 04 00 – General Plumbing Requirements.

B. Demolition of Work

- 1. The Plumbing Contractor shall remove some of the existing plumbing fixtures within this building as indicated on the drawings. The contractor shall be responsible to verify the extent of demolition work and shall include in their bid all demolition work affecting their trade.
- 2. Remove all equipment not used in the final arrangement shown on the drawings including all piping, insulation, hangers, supports, accessories, concrete pads, etc.

C. Installation of Pipe

- 1. Roughing-in and locations of wastes shall be installed as near like the drawings as possible. Where the drawings indicate that the waste exceeds the code requirements, the roughing-in shall be installed in accordance with the drawings and not only to meet the minimum code requirements. Where unforeseen conditions will not permit the installation as shown, no water, waste, etc. lines shall be relocated without the written approval of the Engineer.
- 2. All piping located in pipe spaces must be located so as to insure maximum accessibility. Where necessary to cross pipe space, the crossing must be near the floor or 6 feet or more above the floor.

D. Excavation and Backfilling and Restoration of Surfaces

1. Refer to Division 1 and Section 220400.

E. Equipment

1. Any and all costs associated with piping, electric, wiring, conduit, supports, pads, or other modifications to accommodate installation for manufacturer's equipment that differs from equipment layout on drawings shall be included on contractor's bid. The contractor is responsible to insure that the equipment will fit within space allocated with appropriate clearances for maintenance, operation, servicing, and code.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 220000

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SECTION 220400 - GENERAL PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 PLUMBING WORK

- A. The following paragraphs are applicable to Division 22 and are complementary to other sections of specifications. Where items described in other sections of the specifications are repeated herein, it is done to call special attention to or to qualify them, but it is not intended that any part of the documents shall be assumed to be omitted if not repeated herein.
- B. Where contradictions occur between this section and Division 1, the more stringent of the two shall apply. Architect/Engineer shall decide which is most stringent.

1.2 DRAWINGS AND SPECIFICATIONS

- A. Plumbing drawings are diagrammatic and indicate general arrangement of systems and work included in the contract and shall be adhered to insofar as possible. The drawings and specifications are complementary and are intended, without giving every minute detail, to cover a workable installation complete in every respect including, whether mentioned or not, all material and equipment usually furnished with such systems and/or needed to make a complete operational installation omitting only such parts as are specifically excepted.
- B. Consult drawings and details for exact location of fixtures and equipment, and where not definitely indicated, request this information in writing.
- C. The specification for each division of the work is written in sectional form for brevity and convenience in reference, without repeating in each section all applicable general clauses and/or pertinent data covered elsewhere in the specification, but it is not intended that any of the documents shall be assumed to be omitted if not repeated in each division.
- D. Where specifications are written for brevity, with incomplete sentences, the omission of words or phrases, such as "the contractor shall", "shall be", "provide", "furnish", "all", etc. are intentional and such omitted words or phrases shall be supplied by inference; unless otherwise mentioned, such clauses, lists, and/or directives indicate work to be done by the contractor for that specific division of work.

1.3 VERIFYING CONDITIONS

- A. The work under this contract occurs on the site of and within the existing facility. The work under this contract shall be scheduled and performed so as to provide a minimum of interference with the normal operation of the existing facilities.
- B. Before submitting a proposal, contractors shall visit the site, and shall also carefully examine all bidding documents including those for other branches of the work, to satisfy themselves as to the nature and scope of all work to be done. Prints showing the original building architectural, structural, mechanical, and electrical work are available at the Engineer's office for contractors' review.
- C. The submission of a proposal shall be taken as evidence that such an examination has been made and difficulties, if any, noted. Later claims for labor, work, material, and equipment required for any difficulties encountered which could have been foreseen, shall not be recognized, and all such difficulties shall be properly taken care of by the contractor at no additional expense to the Owner.

1.4 EXISTING WORK AND/OR CONDITIONS

- A. The accompanying drawings and specifications illustrate and describe the existing conditions, mechanical utilities, sewers, water mains, pipes, ducts, conduits, etc. that are particularly relevant to the new work insofar as these mains are shown on existing records or evident by field inspections and tests; however, it is not the intent that these documents shall be construed to guarantee to the contractor the exact location of these items. Each contractor shall verify and determine the exact location of these items in the field, and all work under this contract shall be executed to avoid conflict with or damage to existing work. The work shall be planned and executed to avoid interference, as much as possible, with traffic and with the normal use of the existing facility.
- B. All work involving hazards to persons shall be suitably barricaded and provided with warning lights or signs, as required.
- C. Where necessary for the performance of the contract, existing work shall be cut, altered, removed, or temporarily removed and replaced. Work that is altered or replaced shall match similar existing work and said work shall be performed by trade applicable to the work; if said work is NOT shown or noted the Drawings relating to applicable trade, cost shall be paid by contractor requiring said work. However, unless otherwise provided by the drawings or specifications, no structural members shall be cut or altered without authorization of the Architect and Engineer. Work remaining in place, which is damaged or defaced by reason of work done under this contract, shall be restored in kind equal to its condition at the time of award of the contract by applicable trade as hereinbefore specified.
- D. Existing work shall not be disturbed further than necessary for proper installation of new work. New work to be connected or made integral with existing work shall be properly erected to secure solidity and be continuous in finish. Such new work in extension of existing work shall correspond in all respects with that to which it connects, or similar existing sound work, unless otherwise specified.

1.5 EXISTING MECHANICAL FACILITIES

- A. Where existing mechanical facilities and/or service lines occur in the area of the work and such facilities or lines are to be abandoned or changed, the contractor for the branch of work or trade involved shall cut off and properly cap the old lines, so as not to interfere with the new construction work. If any portions of such lines are required for the operation of an existing building the lines shall be altered and relocated to clear new construction and shall also be restored into service to provide continued operation of the existing building.

1.6 INTERRUPTION OF SERVICES

- A. Work which requires the temporary turning off or shutting down the operation of existing mechanical and/or electrical facilities shall be done at times specifically approved by the Owner or utility company and the work shall be pre-scheduled and executed so there is a minimum outage of such services and/or delay in the new construction work.

1.7 MATERIALS AND EQUIPMENT

- A. All materials and equipment entering into the work shall be approved by the Engineer, and must be new, without defects, and of the sizes and capacities shown on the drawings or hereinafter specified. All manufactured materials or equipment shall bear the identification mark of the manufacturer or, if required by the Engineer, shall be certified by an approved testing laboratory. All equipment shall operate within the manufacturer's range of speeds, guaranteed capacities, performance, etc. as indicated by the manufacturer's latest catalog and/or engineering data, shall be of proper size and dimension for the allocated space, and shall be placed in the space allocated in the proper construction sequence. Special consideration will be given to equipment which has been in successful field use or similar

applications for at least three (3) years (exclusive of field tests), and to equipment which has an extended guarantee period in lieu of long use period. The contractor shall submit with his bid complete data on equipment he proposes to use; failure to so submit, or to meet these requirements fully and those of the specifications, shall be grounds for rejecting the items.

- B. All electrical materials, apparatus, and equipment shall be new, of the make and characteristics specified, shall conform to NEMA standards, and shall be designed to comply with and be installed in accordance with the latest rules and regulations of the National Electrical Code, and all of the legally constituted public authorities having local jurisdiction. Verify the exact voltage and current characteristics at the building before ordering motors or similar equipment.
- C. All motors shall be NEMA frame sizes, heavy duty, 40 degree C. ambient motors with ball or roller bearings and with maximum full load temperature rise not exceeding NEMA limits of temperature rise. All motors shall have adequate starting and protective equipment as specified or required, and shall have a conduit terminal box of size adequate to accommodate conduits and wires as sized on electrical drawings or as specified. The capacity of each motor shall be sufficient to operate associated driven devices under all conditions of operation and load without overloading or overheating and each motor shall be of not less than the horsepower indicated or specified.
- D. Conduct such tests and adjustment of equipment as specified or necessary to verify performance requirements. Submit data taken during such tests.

1.8 QUIET OPERATION

- A. The work shall be installed in such a manner that under all conditions of load it shall operate without sound or vibration which is objectionable in the occupied spaces, in the opinion of the Engineer.
- B. In case of moving machinery, sound or vibration noticeable outside of the room in which it is installed or annoyingly noticeable inside its own room will be considered objectionable. Sound or vibration considered objectionable shall be corrected by the contractor.

1.9 PROTECTION

- A. In performing this contract, safeguard workmen and the public and protect the work and equipment until final completion and acceptance. After delivery and before and after installation, protect work against theft, injury, or damage. Carefully store material and equipment received on site which are not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of obstructing materials. Protect related or adjacent work and the material of the other trades or the Owner from damage that might be caused by this work and make good any damage thus caused. Provide all safeguards, scaffolding, drop cloths, etc. as required.
- B. No welding or soldering shall be done near combustible materials of any kind; all adjoining work, finished surfaces, glass, etc. shall be protected from flames, sparks, hot metal, etc. by metal guards or approved noncombustible drop cloths or barriers.
- C. Each contractor shall replace any items or portions thereof wherever removed or damaged, in a manner equal to the original construction and finish, or where directed by the Engineer, he shall pay other trades to perform this work.
- D. All mechanical equipment with a factory finish shall be protected during construction and must be free of dust, dirt, cement splatters, etc. when the building is turned over to the Owner. Dents and marred finishes shall be repaired to the satisfaction of the Engineer, or a replacement furnished where necessary.
- E. Provide belt drives and rotating machinery with readily removable guards complying with OSHA

requirements to enclose the drive completely and consisting of heavy angle iron frames, hinged and latched, with heavy galvanized iron wire crimped mesh or sheet steel securely fastened to frames.

1.10 EXECUTION OF WORK

- A. The Plumbing work shall be performed and coordinated with the program of the General Contractor and the other subcontractors. Promptly upon award of the contract, the subcontractors shall confer with the General Contractor and the Engineer and other subcontractors to prepare a time schedule for the completion of the various divisions and details of the work. Each subcontractor shall proceed diligently with the work and shall cooperate with the General Contractor and the other contractors to maintain the approved time schedule to the best of his ability and as conditions permit.

1.11 GENERAL SUPERVISION AND INSTALLATION OF WORK

- A. Each contractor shall at all times give the work his best skill and attention, including adequate construction supervision over his work, employees, and subcontractors, and he shall fully cooperate with and confer with the Engineer and other contractors so that the best possible installation shall be obtained. Exact locations and relations are to be determined in the field, subject to the approval of the Engineer, and with preference to the dimensioned and architectural and structural drawings and approved shop and setting drawings.
- B. Unless otherwise shown, pipes, ducts, etc. in rooms with finished ceilings, shall be concealed in furred ceilings, shafts, walls, and floors, and all work must be exactly and accurately located to conform with the spaces provided therefor. In general, all other new piping, ducts, etc. in mechanical equipment rooms, telephone rooms, etc. shall be exposed.
- C. Install pipes, etc. in a neat and workmanlike manner, close to walls, generally as high as possible, true and square to the building, utilizing standard practices, and properly graded for correct functioning of the system involved; multiple lines in close proximity shall be coordinated and neatly grouped. Install work in proper construction sequence and arranged so as to be readily accessible for operation, maintenance, and repair; minor deviations from drawings may be made to accomplish this, but changes of magnitude or which involve extra cost shall not be made without approval. All fixtures, outlets, etc. shall truly center with the adjacent architectural finish. All work, both exposed and concealed, shall meet the approval of the Engineer regarding neatness of appearance, location, and practicability of installation. The Engineer reserves the right to direct the removal and replacement of any item which, in his opinion, does not present an orderly and reasonably neat and workmanlike appearance.
- D. Each contractor shall familiarize himself with the work of the other contractors, shall perform and coordinate his work with the other contractors, shall lay out his work to meet conditions at the building, shall give freedom to and prevent conflict with the work of other contractors, and shall make reasonable modification in locations or arrangement from those indicated on the drawings if required to avoid conflicts or to conform to tile, wood, marble, or other architectural finish. From time to time as the work progresses, the contractor shall examine the work installed by others, insofar as it may affect his work, and he shall, before proceeding with the work, notify the Engineer in writing, if any condition exists which prevents the successful installation of his own work.
- E. If the contractor places any work in violation of any of the above mentioned requirements, and conflicting or unworkmanlike conditions result, he shall, without additional charge, remove and reinstall or satisfactorily readjust such portions of his work as may be necessary and as the Engineer may direct. The Engineer's decision regarding such conditions shall be final.

1.12 ENGINEER'S OBSERVATION

- A. A periodic inspection of the work by the Engineer, commonly referred to as supervision, is only for the express purpose of verifying compliance by the contractor with the contract documents. Such

engineering inspections and services rendered by the Engineer or his representatives shall not be construed as the supervising of construction; nor the assuming by the Engineer of the duties and responsibility of the contractors nor making the Engineer responsible for providing a safe place or procedure for the performance of the work or for the contractor's employees or for subcontractors.

1.13 EXCAVATION AND BACKFILLING OF TRENCHES, ETC.

- A. Unless otherwise specified, the Plumbing Contractor shall do all excavation of trenches for piping, sewers, etc. in connection with his work, and after his work is in place and inspected by the Engineer and Civil Authorities, he shall backfill in layers of not to exceed six inches (6") in depth, thoroughly moistened, thoroughly rammed, tamped, and compacted to a density at least equal to the surrounding earth to minimize after settlement. If, in the opinion of the Engineer, the excavated material is unsuitable for backfilling, the contractor shall backfill with bank run gravel well compacted. The bottom of each sewer trench shall be filled with sand to an elevation of 6" above the top of the sewer. Top of backfill or trench surface shall be level with adjoining ground or surface; furnish additional material if required to fill trenches. All surplus earth shall be moved by this contractor and disposed of as directed by the Engineer. Compact backfill in trenches within building lines the same as specified in architectural branches.
- B. Any sheet piling or shoring or pumping necessary shall be done by this contractor at his own expense and all trenches shall be dug in a careful manner, with bottoms properly pitched to insure perfect drainage and to provide uniform bearing and support for each section of pipe on undisturbed soil along its entire length, except where it is necessary to excavate for bell holes and for the proper sealing of pipe joints. The bottoms of all sewer trenches shall be excavated 6" below the bottom elevation of the sewer and backfilled with sand so at least one-third of the circumference of the pipe will rest firmly on tamped sand. These trenches shall be not less than 12" wider, nor more than 16" wider, than the outside diameter of the pipe to be laid therein; this requirement applies to the width at and below the level of the top of the pipe; the width above that level may be wider for proper sheeting and bracing and the proper installation of the work. Shoring, bracing, barricades, etc. shall be provided to protect the workmen and/or public amply; refer to the Ohio Bulletin No. 201 "Specific Safety Requirements Relating to Building and Construction Work".
- C. Unless otherwise approved, the following minimum cover shall be provided above the top of underground pipes outside the buildings: Water lines, 4'-0"; gas lines, 3'-0"; sewers, refer to elevations on plans.
- D. Whenever wet or otherwise unstable soil, that is incapable of properly supporting the pipe as determined by the Engineer, is encountered in the trench bottom, such soil shall be removed to a depth required and for the length designated by the Engineer, and the trench backfilled to trench bottom grade with coarse sand, fine gravel, or other suitable materials, properly compacted.
- E. Excavation near or under building footings shall be backfilled with concrete installed under the direction of the Engineer.
- F. Where contractor elects to have any excavation work performed by a subcontractor, subcontractor must be approved by the Owner prior to commencing any work.

1.14 RESTORATION OF SURFACES AND CONCRETE WORK

- A. Unless otherwise specified, all new concrete work for parking lots, driveways, pads, etc. shall be provided by the general contractor unless otherwise specified. All new concrete work for pads, and all surfaces such as concrete floors, walls, paving, sidewalks, roof deck, or other surfaces disturbed in the execution of work, and which remain in use, shall be restored in kind by this contractor, or he shall pay the cost of such work.

- B. Where this contractor has performed excavation work, this contractor shall backfill as hereinbefore specified in Paragraph 1.16.
- C. In Landscaped Areas, such as grass or plantings, the final 6" of backfilling, grading, seeding, mulching, and planting shall be performed by a qualified, competent Landscaping Contractor. The Plumbing Contractor shall include in his bid the cost of such landscaping services and shall warrant same as described under Paragraph 24.
1. This final 6" of backfill provided by the approved Landscaping Contractor shall consist of top soil complying with Ohio DOT 653.02; ph 6.0 to 7.0 or adjusted within these limits, raked to a uniform fineness and free of rock or stones 1" or greater in any dimension.
 2. Where grass has been disturbed, the Landscape Contractor shall apply 8/32/16 organic fertilizer at rate of 1 lb. per 5 square yards and seed with 90-95% pure, 85% (minimum) germination seed of a mixture of 20% Rye grass, 40% creeping red fescue, and 40% Kentucky blue grass at a rate of 7 lbs. per 1000 square feet. Cover seeded areas with clean, weed free straw.
 3. If shrubbery and plantings must be disturbed, the Landscaping Contractor shall either remove, maintain, and reinstall said plantings or the Landscape Contractor shall furnish healthy new shrubbery and plantings similar in kind to that which was removed. In either case, the Landscape Contractor shall fertilize and provide mulch around said plants.
- D. In Blacktop Paved Areas, the work shall be performed by a qualified, competent Blacktop Contractor; bids shall be based on and work shall comply with the following:
1. All materials and workmanship shall comply with the latest edition of the State of Ohio Department of Transportation Construction and Material Specification.
 2. Paved areas shall match existing slopes and shall be without dips or low spots. All seams in paving to be flush and tight.
 3. Begin rolling when mixture will bear roller weight without excessive displacement. Repair surface defects with hot material as rolling progresses. Cut out and patch defective areas and roll to blend with adjacent satisfactory paving. Continue rolling until maximum density is attained and roller marks eliminated.
 4. Protect newly placed material from traffic until mixture has cooled and attained its maximum degree of hardness.
 5. Remove and replace mixtures that become contaminated with foreign materials and defective areas and fill with fresh, hot mix properly compacted. Remove deficient areas for full depth of course. Cut sides perpendicular and parallel to direction of traffic with edges vertical. Apply tack coat before placing new mixture.
 6. Thickness of Paving shall be as follows:
 - a. Base: ODOT-301, compacted thickness 9".
 - b. Prime Coat (over base): ODOT-408, 3.0 Gallons/Square Yard.
 - c. Wearing Course: ODOT-404, two separate 1-1/2" layers each compacted; total compacted thickness 3".
 - d. Tack-coat: ODOT-407, 0.20 Gallons/Square Yard.

7. Restore all parking space lines and space numbers using materials in accordance with Ohio Department of Transportation Section 621 - Pavement Marking.
8. Concrete Work, shall be performed by a qualified, competent, Concrete Contractor, and work shall comply with the following:
9. Sidewalks shall be concrete, Class C, unreinforced, complying with ODOT 608. Width and finish shall match existing adjacent sidewalks. Sidewalks shall be the same depth as the existing adjacent sidewalks or 7" deep whichever is greater.
10. All other concrete for parking lots, driveways, and pads shall be 4000 PSI compressive strength concrete with reinforcing steel. Thickness of concrete for parking lots and driveways shall be not less than 7" thick. Reinforcing steel shall be 6" x 6" 58 pound welded wire fabric (WWF) top and bottom. All welded wire fabric shall be in flat sheets, not rolls.

1.15 SLEEVES, CUTTING, PATCHING, CLEANING, WATERPROOFING, ETC.

- A. Provide and accurately set frames and Schedule 40 steel pipe sleeves for required openings in new work to minimize cutting. Perform all cutting, patching, etc. required to install the work. Use approved power operated boring machine for small holes wherever practical. Remove all rubbish incidental to the work. Where any work pierces waterproofing, provide all necessary sleeves, caulking, and flashing required to make openings absolutely watertight.
- B. Refer to the ACI Code 381.71, Section 6.3 for limitations and requirements for penetrations and openings.

1.16 PATENTS

- A. The contractor shall defend and guarantee the Owner against any expense, claims, litigation, etc. occasioned by the use in this work of any materials, devices, etc. covered by patents not owned by the contractor, or of which he is not a licensed user.

1.17 CONTEMPLATED WORK

- A. The work contemplated occurs on the site of and within the existing building.
- B. The drawings and specifications for the mechanical and electrical portion of this project have been prepared by Motz Consulting Engineers, Inc., doing business as Motz Engineering.
- C. The various items of work necessary for completion of this work are hereinafter specified under the respective section headings or shown on accompanying drawings, and shall be included in any contract or contracts made for completion of respective divisions of the work. Such contracts shall also include necessary details reasonably incidental to the proper execution and completion of such work.

1.18 MOVING MATERIALS

- A. If it becomes necessary at any time during the progress of this work to move materials which have been temporarily located and which are to enter into the final construction, the contractor furnishing said materials shall, when so directed by the Engineer, move them or cause them to be moved. Cost of such moving shall be included in the contract price.

1.19 ACCIDENT PREVENTION

- A. Precaution shall be exercised at all times for the protection of persons and property. The safety provisions of applicable law, building, and construction codes shall be observed. Machinery,

equipment, and other hazards shall be guarded in accordance with safety provisions of the "Manual of Accident Prevention in Construction" published by Associated General Contractors of America to the extent that such provisions are not inconsistent with applicable law or regulations.

1.20 PROPERTY PROTECTION

- A. All hoisting shall be done with proper tag lines and buffers to prevent damage to the sides of the building. Where it is necessary to hoist materials to the roof, the parapets at top of the building and the roof where materials are landed from hoists shall be protected with heavy wood covers. Parapet protection shall be placed on both sides and top, and shall extend far enough on either side of landing point to insure adequate cover. The roof, from the landing point at parapet to final location of material, shall be adequately protected by planks laid side by side on roofing and spiked together on outside edges with planks running at right angles to main planking. The roof shall be adequately protected against leaks at all times.
- B. Where hoists are erected on the roof for hoisting material up the side of the building, the roof shall be adequately protected against abrasion or other damage. Materials stored on the roof shall be placed on planks or other protection approved by the Engineer and shall be placed only at locations approved by the Engineer.
- C. If hoisted materials are taken through windows, the jams, head, and sill shall be adequately protected with wood planking or proper buffers.
- D. Any work, equipment, or property damaged during construction of this project and due to operations under this contract shall be repaired or replaced by this contractor, without additional cost to the Owner. Upon completion of the work, the contractor shall remove all protections herein specified.

1.21 REMOVAL OF RUBBISH

- A. It shall be each contractor's duty to keep the building and surrounding premises clean, free from rubbish of every description. No rubbish, crating materials, packing, or dirt shall be allowed to accumulate at any time, but shall be removed at once and hauled away.
- B. Each trade shall be responsible for its own tools and materials during the periods of rubbish removal but contractors shall use reasonable care in removal of rubbish to protect the tools and materials of others against loss or damage. The Owner reserves the right, in the event that removal of rubbish is not promptly and properly carried out by the Contractors to have rubbish removed and to charge the cost of its removal to the contractor.
- C. Also, refer to Division 1.

1.22 MATERIAL SAFETY DATA SHEETS (MSDS)

- A. The contractor shall obtain and maintain on-site during the course of the project the Material Safety Data Sheets (MSDS's) for all chemicals or products containing chemicals that may be considered toxic or hazardous. The MSDS's are to be forwarded to the Office of Environmental Health and Safety upon completion of the project.

1.23 INSTRUCTION OF PERSONNEL

- A. The Plumbing Sub-Contractor shall provide free on site instruction in the proper use of installed equipment to designated representatives of the Owner, sufficient to ensure safe, secure, efficient, non-failing utilization, and operation of systems. This instruction shall include the following:
 - 1. On Site Training: Provide a minimum of 4 hours of training for Owner's staff. Submit a

syllabus to the Engineer prior to the first session.

2. Support: Provide a minimum of 4 hours of support either on site or by telephone to answer operations questions.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 220400

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SECTION 220500 – COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The General Conditions, Special Conditions and Division 1 through Division 32 as set forth in these specifications are hereby incorporated into and shall become a part of the specifications for work under this title, insofar as they apply hereto.
- B. Furnish material, labor, tools, accessories and equipment to complete and leave ready for operation of the Plumbing system for this project as described in these specifications and as shown on the drawings, or as required.

1.2 REGULATORY REQUIREMENTS

- A. Conform to all utility company regulations.
- B. Secure and pay for all necessary permits, fees and inspections and prepare all drawings required by applicable local and state codes.
- C. Obtain all inspections or additional permits required by all laws, ordinances, rules, regulations or public authority having jurisdiction and obtain certificates of such inspections and permits and submit same to the Architect. The Contractor shall pay all fees, charges and other expenses in connection therein for Plumbing work including inspection fees, etc. associated with the building permit.
- D. Perform all work in strict accordance with all applicable laws, codes, regulations and rulings of State, City, County, Local, Utility Company, EPA and requirements of all authorities having local jurisdiction. In case of conflict between the drawings and/or specifications and the above requirements, the more rigid requirements shall govern.
- E. Unless otherwise noted, the following latest enforced Edition shall apply to this work:
 - 1. State and Local Plumbing Code
 - 2. Sewer Department
 - 3. Water department
 - 4. National Fire Protection Association
 - 5. Life Safety Code
 - 6. Fire Code
 - 7. Building Code
 - 8. OSHA Requirements
 - 9. EPA Requirements
 - 10. County Building Requirements
 - 11. City Fire Department Requirements
 - 12. City Building Requirements
 - 13. Public Schools Building Requirements

1.3 QUALIFICATIONS

- A. Installer: Company specializing in performing work of this Section with minimum three years documented experience.

1.4 MATERIALS, MANUFACTURERS AND SUBSTITUTIONS

- A. Unless otherwise specifically indicated, furnish materials and equipment which are new.
- B. When two or more products are named together in the specifications, bids shall be based upon any of the products named upon consideration of the following requirements. The product named first has been used in the design.
- C. The bidder shall ascertain that the product upon which he chooses to base his bid has the specific features enumerated and is equal, that it will properly fit the space and the adjacent work. Any additional costs, including cost of work by others, involved in completing the work with said products and the responsibility for its fitting and operating as a part of the system rests solely with the bidder.
- D. These specifications permit the bidder to propose for consideration with his bid and must be indicated on the substitution sheet, any one of a like material that is generally considered to be equal to the manufacturers named in the specifications. However, the bidder shall base his bid on the name or make of any article, device, material, form of construction, fixture, etc., named in the specifications.

1.5 WARRANTIES

- A. In addition to requirements of Division 1, contractor shall turn over to the Owner all certificates of equipment guarantee and/or warranty covering remaining guarantee and/or warranty period at end of his guarantee period.
- B. In addition to requirements of Division 1, provide all services necessary to assure the proper operation of all systems installed under this section of the specifications for one year after final acceptance. Completely inspect the systems at least twice during that time, at the change of seasons, and make any necessary adjustments in system. Two weeks before the date for beginning each of the inspections, inform the Engineer in writing. The requirement for inspections is not intended to, nor is the contractor obligated to perform any work during the one year period which, in the opinion of the Engineer is normal maintenance. However, if faulty or defective parts are found during the inspections repair or replace them in accordance with the guarantee provisions of these specifications.
- C. In addition to compliance with the Conditions of the Contract, the Contractor is hereby made aware that certain manufacturer's equipment guarantees are valid only for a period of one year from the date of shipment or installation and will, therefore, not be valid until the date of guarantee set forth herein. The Contractor will, therefore, be responsible for all material, labor, and equipment for the full guarantee period as set forth herein.
- D. Furnish labor and material required to fulfill the requirements of this guarantee at no additional cost to the Owner.
- E. Owner pre-purchased equipment is not to be included in contractor's warranty. However, pre-purchased equipment installation is to be included in the contractor's warranty.

1.6 QUALITY ASSURANCE

- A. The Plumbing Contractor shall be responsible for all costs associated with changes to valve, pipe sizes, sprinkler heads, etc. caused by the change of equipment from the basis of design specified to other named manufacturers. The Contractor is responsible to insure that the other manufacturer named supplied equipment will fit within space allocated, with appropriate clearances for maintenance, operation, service, code requirements, etc. Any contractor utilizing a manufacturer other than basis of design shall be responsible for any additional requirements for electrical service, concrete pad size, physical space limitations, and capacities at no additional cost to Owner. If manufacturers are listed, no other manufacturers except those listed within the Sections of this Division, that are in turn able to comply with the contract document requirements and minimum standards of these specifications, will be acceptable.
- B. Work provided or performed by the Contractor shall be guaranteed to be replaced and made good at his own

expense any defects which may develop, within one (1) year after final payment and acceptance by Owner, due to faulty workmanship or material, upon receipt of written notification of the defect from the Owner.

1.7 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Proposed Products List: Include Products specified in Sections 22.
- C. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories in a single submittal.
- D. Mark dimensions and values in units to match those specified.
- E. Submit prior to any shop drawing submittals for the Associate Engineer's review: A proposed list of equipment to be submitted 7 days after letter of intent or award of contract, whichever is first.
- F. In addition to provisions of Division 1, submit (8 sets) of shop drawings having each sheet (except pages bound in a brochure) and each brochure marked with identification, and containing information described below. To facilitate coordination, submit all
- G. Drawings in logical order. Submit mechanical assembly drawings, where possible, complete with all related subassembly drawings, wiring diagrams and necessary data.
- H. Identification to Include:
 - 1. Project name.
 - 2. Identification by specification heading number under which equipment or material is described and by name, number, and intended use as designated by contract drawings and specifications.
 - 3. Information: Include the following data:
 - a) Manufacturer's model number or catalog number, size and performance curves and data. Indicate operating points on curves and tabular data, for each piece of equipment that curves or data represent.
 - b) Indication of all performance data, construction materials, finishes and modifications to manufacturer's standard design called for in specifications.
 - c) Roughing in, foundation, and support points dimensions.
 - d) Electrical information, including elementary diagrams, connection diagrams and nameplate data.
 - 4. Any shop drawings not in compliance with above will be returned, without review, for correction and re submittal.
 - 5. In addition to the above, provide shop drawings for the following items:
 - a) Coordination drawings.
 - b) Maintain one copy of approval documents on site.

1.8 COORDINATION DRAWINGS

- A. General:
 - 1. The HVAC Contractor shall be in charge of the coordination drawing process and shall be responsible to resolve all conflicts and settle any disputes resulting from the coordination drawing process.

2. Contract drawings are diagrammatic. Included in the base bid shall be all offsets, fittings, etc. for a completed project. Only if major rerouting of piping is required, with significant cost increases, as approved by the Owner's Representative, Architect and Engineer, will additional money be warranted.
3. Field discrepancies shall be resolved by the field foreman. When discrepancies cannot be resolved, the signed-off coordination drawings shall be re-examined for rights.
4. Documented, coordinated, dimensioned work will have precedence. Owner will not pay for rework of a particular trade. Uncoordinated work will not be tolerated.
5. Coordination drawings shall be a phased process with the General Contractor, MEP Contractors, Architect and Engineer determining the sequence of work.
6. Each Contractor shall coordinate the exact location of their work with the work of other trades prior to fabrication or installation of same. Verify all dimensions and elevations. Provide additional offsets and sections of material as may be required to meet the applicable job condition requirements. Coordinate with and review all related Construction Drawings and Shop Drawings of all equipment suppliers prior to start of work.

B. Process

1. The Sheet Metal Sub-contractor shall have precedence for the allotment of available space. Ductwork rerouting for gravity drain lines may be required and shall be approved by the Engineer.
2. The Sheet Metal Contractor shall be responsible for all trades, pre-coordinating their layouts and shop drawings with each other, including the Sheet Metal Contractor.
3. The Sheet Metal Contractor shall prepare a BIM model (Revit or Navisworks). He shall be responsible for the base drawings to be used by all other Contractors. Base drawings shall include architectural, structural and reflected ceiling plan information.
4. The Sheet Metal Contractor shall prepare ductwork drawings, at a minimum scale of 1/4" = 1'-0", in a BIM model (Revit or Navisworks). After he has finished, a CD with base drawing and ductwork shall be circulated in the following order:
 - a) Plumbing Contractor
 - b) Piping Contractor
 - c) Electrical Contractor
 - d) General Contractor
5. Each Contractor shall use the diskette for preparation of their installation drawings.
6. After all trades have completed the coordination process, the General Contractor shall hold a coordination meeting to resolve conflicts. Each Contractor shall have available a drawing of his layout to be used with a light table for overlaying purposes. A representative of each Contractor, the Architect and the Engineer shall attend. All conflicts shall be resolved at the coordination meeting. The Architect and Engineer shall resolve all major conflicts as to the degree each Contractor shall alter their layout in order to allow for sufficient space for installation of the work.
7. When all coordination is complete, the Sheet Metal Contractor shall distribute two (2) sets of prints of the coordination drawings to each of the trades involved in the project, one (1) set for the owner's representative and one (1) set for as-built drawings.

C. Plumbing, HVAC Piping, and Electrical Contractors:

1. Piping and conduits shall be located and dimensioned from column center lines. Size, center line elevation and

- required pitch shall be clearly noted.
2. Long drain lines shall have center line elevations indicated at 20' intervals.
- D. General Contractor:
1. All furring and holes shall be clearly noted.
 2. All ceiling heights shall be clearly noted.
- E. Service Areas:
1. Contractors shall indicate service areas for all equipment by shaded areas on drawings.

1.9 OPERATING INSTRUCTIONS

- A. Instruct the Owner's personnel in the details of operation and maintenance of all Contractor furnished equipment. Instructions shall be based on operating annuals furnished for the equipment, and shall demonstrate procedures and methods described in manuals.
- B. Arrange and pay for the services of qualified personnel from the manufacturer's of various major equipment for instruction. Provide this operating instruction for three working days of not less than eight hours, starting from the time that the entire system (or if sections are to be started at various times, from the time that each section) is in satisfactory operation. Time spent in making trial runs, changes, or major adjustments not to be included in the instruction time.
- C. In addition to requirements of Division 1, provide:
- D. Mechanical Booklet and Operations Instructions: Submit three (3) manuals, bound in the best grade hardback, loose-leaf, 3-ring binders, of all operating and maintenance instructions presenting full details for care and maintenance of all mechanical and electrical equipment installed, including air conditioning systems and equipment. The operating instructions shall include the following information:
 1. Operating Instructions Manuals:
 - a) Provide written instructions, of the following format, for each system with submittal of invoice for 75% of total contract.
 - b) Submit one copy for approval before releasing to the Owner.
 - c) Upon receipt of the approval, submit three copies to the Engineer.
 - d) Bind the written operating instructions, shop drawings, equipment catalog cuts and manufacturer's instructions into a hard backed binder where they can be accommodated into a size 8-1/2" X 11".
 2. Provide multiple binders where one cannot accommodate information.
 - a) First Page - Title of job, Owner, address, date of submittal, name of Contractor and name of Engineer.
 - b) Second Page - Index or Table of Contents.
 - c) Third Page - Introduction to first section containing a complete written description of systems.
 - d) First Section - Written description of system contents, where actually located in the building, how each part functions individually, and how system works as a whole. Conclude with a list of items requiring service and either state the service needed or refer to the manufacturer's data in the binder that described the proper service.

- e) Second Section - A copy of each shop drawing with an index at the beginning of the section.
- f) Third Section - A copy of each manufacturer's installation instructions.
- g) Fourth Section - A copy of each manufacturer's operating instructions and parts lists along with recommended spare parts lists with index at the beginning of the section.
- h) Fifth Section - A copy of each manufacturer's maintenance instructions
- i) Sixth Section - A list of all equipment used on the job, Contractor's purchase order numbers, supplier's name and address, date of start-up of each piece of equipment.
- j) Seventh Section - Copies of all control wiring and flow diagrams, valve charts, pertaining to the work including automatic temperature control diagrams.

1.10 RECORD DRAWINGS

- A. In addition to Division 1, keep on the job one complete set of working drawings on which he shall record any deviation or changes made from contract drawings made during construction. Record drawings shall show changes in:
 - 1. Size, type, capacity, etc. of any materials, device, or piece of equipment.
 - 2. Location of any device or piece of equipment.
 - 3. Location of any outlet or source in building service systems.
 - 4. Routing of any piping, conduit, ducts, sewers, or other building services.
- B. These drawings shall also record the location of all concealed water and electric service, water piping, sewers, wastes, vents, ducts, conduit and other piping by identification of measured dimensions to each such line from readily identifiable and accessible walls or corners of the building. Drawings also show invert elevation of sewers and top of water lines.
- C. These drawings shall be kept clean and undamaged, and shall not be used for any purpose other than recording deviations from working drawings and exact locations of concealed work.
- D. After the job is completed these sets of drawings shall be delivered to the Engineer in good condition, as a permanent record of the installation as actually constructed.

1.11 SPARE PARTS AND MAINTENANCE MATERIALS

- A. Provide products, spare parts, maintenance and extra materials in quantities specified in individual specification sections.
- B. Deliver to owner to location as directed; obtain receipt prior to final payment.

1.12 DRAWINGS AND SPECIFICATIONS

- A. It is intended that work covered by these specifications and drawings include everything requisite and necessary to make the various systems complete and operative, irrespective of whether or not every item is specifically provided for. Any omission of direct reference herein to any essential item shall not excuse contractor from complying with the above intent.
- B. Figured dimensions supersede scaled ones. Contractor shall take no advantage of, and shall promptly call the Owner's Representative attention to any error, omission or inconsistency in specifications and drawings.

- C. Special attention is directed to requirements that equipment and materials stated in specifications and/or indicated on drawings shall be furnished, except if otherwise noted, completely installed, adjusted and left in safe and satisfactory operating condition. Accessories, appliances and connections necessary for operation of equipment shall be provided to satisfaction of the Owner's Representative.
- D. Materials, apparatus or equipment specified or otherwise provided for on drawings, addenda, or change orders issued subsequent to award of contract shall be same brand, type, quality and character originally specified unless otherwise provided.
- E. Layout of equipment, accessories, specialties and suspended, concealed or exposed piping systems are diagrammatic unless dimensioned. In preparing shop drawings, contractor shall check project conditions before installing work. If there are any interferences or conflicts, they shall be called to attention of the Engineer immediately for clarification.
- F. The drawings indicate required size and points of termination of pipes and ducts and suggest proper routes to conform to structure avoid obstructions and preserve clearances. However, it is not intended that drawings indicate all necessary offsets, and it shall be the work of this contractor to make the installation in such a manner as to conform to structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further obstruction or cost to the Owner.
- G. Shop drawings shall be furnished by this contractor, indicating all changes to meet space requirements, code requirements and as necessary to resolve all space conflicts. Ductwork shall be fabricated from contractor's shop drawings and cut sheets and not from contract drawings.
- H. It is intended that all apparatus be located symmetrical with architectural elements, and shall be installed at exact height and locations as shown on the architectural drawings. Refer to architectural details in completing and correlating work.
- I. The contractor shall fully inform himself regarding any and all peculiarities and limitations of the spaces available for the installation of all work and materials furnished and installed under the contract. He shall exercise due and particular caution to determine that all parts of his work are made quickly and easily accessible.
- J. The contractor shall carefully examine any existing conditions, existing piping and ducts and premises and compare the drawing with the existing conditions.
- K. It cannot be too strongly emphasized that, except for work specifically excluded herein, every system shall be turned over to Owner installed completed, with components, ready for normal operation.
- L. Modify existing systems by rerouting for systems to remain or remove for abandoned systems as required to accommodate new general construction, Fire Suppression, electrical and mechanical work.
- M. Concealment:
 - 1. Unless otherwise specified, all work aboveground to be above suspended ceilings and in walls except in the Mechanical Equipment Room and areas without ceiling work to be as high as possible.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 PROJECT CONDITIONS

- A. Install Work in locations shown on Drawings, unless prevented by Project conditions.
- B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of Owner Representative before proceeding.
- C. Drawings indicate desired position of equipment and routing of pipe and ductwork. Coordinate routing of pipes, ductwork and all other installations with installations of other trades prior to making installations.

- D. Replace and restore to their original undamaged condition, facilities of every description damaged or disturbed during progress of work. Such replacement or restoration applies to both surface and subsurface installations and materials. This includes fences for security, access routes, sidewalks, etc.
- E. Where cutting of building structure such as floors, walls, roof, or framing is necessary, perform cutting operations only as authorized by the Owner's Representative as specified in Division 2. Cutting and patching of existing and new facilities shall be included in this Contract. Patch and finish all such openings in accordance with the applicable requirements given in other sections of these specifications.
- F. Patching shall be done by workmen skilled in the trade involved. Holes cut in structural steel must be drilled or punched, not burnt with torch.
- G. Remove existing ceiling and replace after work is tested. Repair and/or replace any damaged materials as directed by the Owner's Representative. Cutting and patching by this contractor to be as specified in Architectural Sections.
- H. Patch, close and seal all new and existing openings used by this contractor. Where openings are used by more than one trade, each trade to be responsible for an equal share of patching, closing and sealing openings.
- I. Tie-in to existing installations as indicated on the drawings and specified hereinafter. Complete the work to assure proper operation of each system with least possible damage to an interference with surrounding construction and using materials specified or to match existing.

3.2 SEQUENCING AND SCHEDULING

- A. Construct Work in sequence under provisions in Division 1.
- B. Coordinate completely all phases of and scheduling of work with the Owner's Representative and with other trades. Obtain approval from the Owner's Representative prior to execution of any work.
- C. The existing facilities will remain in service throughout the construction operation with brief shut down periods permitted for making tie-in connections.
- D. Interruption of existing services and facilities will be permitted only when the facilities are not required. The cost of premium time for scheduling interruptions on weekends and during evening hours as required by the Owner's Representative operating schedule to be included in the bid amount. This means that both the cost of doing the work during the normal working day and the premium charges for weekend and evening hours to be included in the bid amount.
- E. Make temporary connections where and when necessary to maintain existing systems in operation and replace temporary connections with permanent connections as soon as possible.

3.3 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. In addition to Division 1, protect piping ductwork and equipment at all times against entrance of dirt and injury to pipe joints, sheet metal, sheet metal acoustical lining and equipment surfaces during construction by means of caps, plugs, canvas, mounting on skids or plastic covers.
- B. During shipment and before and during erection, protect materials and equipment from weather damage. Keep materials and equipment off ground by means of wood blocks or skids. Follow manufacturer's suggested procedure for protection of equipment which will be idle for an extended period of time prior to start-up.

3.4 DEMOLITION

- A. Disconnect all systems piping, ductwork, equipment, trim and accessories that are to be removed from systems that are to be maintained and used in the existing facility. Cap or plug all systems that are to remain in service. Demolition work to be scheduled as directed by the Owner's Representative. All costs for temporary connection to maintain the existing systems in operation after demolition of portions of the facility to be included in this contract. This contract to do all demolition shown on the drawings. All systems not reused are to be removed from the

facility unless indicated otherwise.

- B. Building demolition that is to be done by the General Contractor is specified in Division 1. Do all demolition work not done by the General Contractor. This includes abandoned systems in walls, ceilings and chases that remain.
- C. Demolition to include all cutting, patching, excavation, backfill, removal and reworking all items in accordance with the applicable requirements given in other sections of these specifications.
- D. Patch all walls, floors, roofs, ceilings where mechanical items are removed to provide finished surfaces to match adjacent surfaces.

3.5 EXCAVATION AND BACKFILL

- A. Perform all excavation and backfill required to complete the working accordance with Division 2 Earthwork. Protect excavations, barricade walkways and minimize pedestrian disruption.

3.6 CONCRETE WORK

- A. Provide all concrete pads and do all concrete work in accordance with Division 3.

3.7 PROTECTION AND DAMAGE

- A. In addition to the provisions and stipulation of the General Conditions, provide various types of protection as follows:
 - 1. Protect finished floors from chips and cutting oil by the use of metal drip receiving pan and oil proof floor cover.
 - 2. Protect equipment and finished surfaces from welding and cutting splatters with baffles and splatter blankets.
 - 3. Protect equipment and finished surfaces from paint droppings, insulation adhesive and sizing droppings, etc. by use of drop cloths.
- B. All equipment shall be stored at the site with openings, bearings, etc., covered to exclude dust and moisture. All stock piled pipe shall be placed on dun age and protected from weather and from entry of foreign material.
- C. Piping and construction openings and excavations required for Plumbing work shall be covered when work is not in progress as follows:
 - 1. Cap pipe openings with fittings or plugs.
 - 2. Cover wall and ceiling openings with plywood, or canvas covered framing.
 - 3. Cover floor openings and excavations with structural material of adequate strength to support traffic.
- D. The Owner's property and the property of other Contractors shall be scrupulously respected at all times (including damage from leaks). Provide drop cloths and visqueen or similar barriers where dust and debris is generated, to protect adjacent area.
- E. Contractor shall be held responsible for damage caused by his work or through neglect of his workmen. Repairing of damaged work shall be done by Contractor as directed by the Architect. Cost of repairs shall be paid by Contractor.
- F. The Owner reserves the right to make emergency repairs as required to keep equipment in operation without voiding the Contractor's guarantee bond not relieving the contractor of his responsibilities during the bonding period.

3.8 TESTING AND ADJUSTING

- A. Furnish all necessary temporary equipment and instruments required for adjustments and for operating tests. Submit list of instruments which will be used, including data of most recent calibration of each instrument.

- B. When a test is to be made, notify the Owner's Representative not less than 48 hours before the test is scheduled to start, so that he may witness the test, or any part of it, if they elect to do so. The start of any test or handling system may also be deferred by not more than two working days if the proposed date conflicts with other commitments of the personnel assigned to witness the tests.
- C. Pressure Tests:
1. Test piping and prove tight, at the hydrostatic pressures Test piping which is to be concealed before the installation of concealing construction is started. Disconnect devices, equipment and attached piping which are not designed for the test pressure,

and install plugs and blind flanges to close openings. listed below for a period of 2 hours for each test:
 2. Water piping, Storm, soil, waste, vent and drain piping - test with water or air, prove tight to satisfaction of inspection authorities and architect/engineer. Natural gas piping test to 75 psig with compressed air.
 3. Replace work found defective, or repair if so directed.
- D. Soil test per Division 2.
- E. Equipment:
1. After satisfactory testing and cleaning of all piping as specified herein, placement all equipment in operation. Pressure test equipment to rated pressure for a period of 2 hours.
 2. Take all necessary reading to determine that equipment is operating satisfactorily. This includes temperatures in and out as well as ampere readings and voltage readings of all phases.
- F. Adjusting and Balancing:
1. After satisfactory testing and cleaning of all piping as specified hereinbefore, place all equipment in operation and adjust as required for proper operation.
 2. For starting-up and adjusting of Contractor furnished equipment except as specified hereinafter, which is not within the normal function of the Contractor's personnel, arrange and pay for the services of employees of the manufacturer's of various major items of equipment to supervise such adjustment and initial operation.
 3. If the Contractor elects to provide such service for any equipment with his own personnel, and this proves unsatisfactory in the opinion of the Owner's Representative, the Contractor shall, upon notification of such dissatisfaction, arrange immediately for services of manufacturer's employees as specified above.
 4. Contractor shall add to systems any devices required for proper balancing.
- G. Test Reports:
1. After all tests have been completed, or at intervals during the testing if requested by the Owner's Representative, submit data on motor load readings on each phase and simultaneous voltage readings across each phase with motor nameplate data.

3.9 OPERATION OF SYSTEM

- A. After the entire system has been adjusted, operate it for not less than three working days of not less than eight hours each to demonstrate that performance is satisfactory and that each item of equipment has the capacity specified. If the Engineer agrees or directs major portions of the system may be so operated at different times in lieu of operations of the entire system at once. Correct all operating deficiencies observed during the test runs.
- B. When excessive vibration of equipment is noted during this operation, have the manufacturer's representative check

shafts, motors, motor supports, fan wheels, sheaves, equipment mountings, bearings and couplings and other components of the equipment which are vibrating.

- C. Make all corrections necessary to eliminate the vibration to the satisfaction of the Engineer.
- D. When the Engineer deems it to be necessary to do so, make another test after corrective work is completed for the full period specified above.
- E. After replacement or repair, test work again as specified. Repeat until satisfactory.
- F. Keep complete and accurate record of test data. Submit to the Owner's Representative, in triplicate, typewritten report of all test data.
- G. Provide restraints to eliminate all excess pipe movement.

3.10 ACCESS PANELS

- A. Provide access panels where required for access to concealed equipment, valves and piping. Location of all access panels shall be approved by the Architect/Engineer.
- B. Panel size shall be adequate for service intended. Use fire rated UL listed access panels in fire rated ceilings or walls.
- C. Access panels shall be per access panel spec section in division 8.
- D. Access panels shall have locks in accordance with division 8.

3.11 FINISH

- A. Prime piping and structural and/or supporting steel members or parts that are exposed with one coat of Porter gray primer, or equal, after work is in place.
 - 1. Clean and re-paint any factory or shop painted surfaces that are damaged, scarred or with signs of corrosion. Painting to match original factory paint.
 - 2. Clean surfaces to remove all dirt, oil, grease dust, scale and foreign matter before applying paint. Designate all piping with temporary removal markings for guidance during priming and painting.
 - 3. All primer and paint shall be manufactured by Foy Johnston Porter, Pittsburgh Plate Glass Industries, Martin-Marietta, DuPont or equal.
 - 4. Shop fabricated or Manufactured Equipment and Materials.
 - 5. Unless factory finished is specified, prime, prior to shipment to job. If prior painting is not part of manufacturer's standard procedure, paint equipment and materials immediately after they are put in place, as specified for field painted items.
 - 6. Items not to be painted:
 - a) Galvanized or similarly treated surfaces unless furnished as part of unitary assembly.
 - b) Non-ferrous surfaces
 - c) Non-metallic surfaces
 - d) Plated surfaces
 - e) Inside of pipes, conduits and electrical devices

- f) Gearing and machine finished surfaces
 - g) Underground piping, unless otherwise specified.
- B. Painting:
- 1. Refer to Division 1, for requirements.
 - 2. Clean surfaces to remove all dirt, oil, grease, dust, scale and foreign matter before applying paint.
 - 3. Finish painting to be done per Division 9 - Finishes or as specified within individual sections of this specification.
- C. Permanent Identification:
- 1. After piping has been insulated and finish painted identify all exposed piping with painted stencils. See Section - Mechanical Identification.

3.12 FINAL CLEANING

- A. In addition to the requirements of Division 1.
- B. The Contractor shall provide final cleaning of the work consisting of cleaning each surface or unit of work to normal "clean" condition expected for a first-class building cleaning and maintenance program. Comply with the manufacturer's instructions for cleaning operations. The following are examples, but not by way of limitation, of cleaning levels required:
- C. Remove labels which are not required as permanent labels.
- D. Clean transparent materials, including mirrors and window/door glass, to a polished condition, removing substances which are noticeable as vision-obscuring materials. Replace broken glass.
- E. Clean exposed exterior and interior hard-surfaced finishes, including metals, masonry, concrete, painted surfaces, plastics, tile, wood, special coatings and similar surfaces, to a dirt-free condition, free of dust, stains, films and similar noticeable distracting substances. Except as otherwise indicated, avoid disturbance of natural weathering of exterior surfaces. Restore reflective surfaces to original reflective.
- F. Clean concrete floors broom clean.
- G. Clean project site, including landscape, development areas, of litter and foreign substances. Sweep paved areas to a broom-clean condition; remove stains, petro chemical spills and other foreign deposits. Rake grounds which are neither planted nor paved, to a smooth, even-textured surface.
- H. Remove all debris and clean dirt free all interiors of air handling equipment including coils, fans, dampers and ductwork. Clean to a visible dust and dirt free condition the inside of ductwork and replace filters on all systems that have been used for temporary heat or ventilation during construction.

3.13 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. 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.
- 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 to permit valve operation and servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - c) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - d) Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast- brass type with polished chrome-plated finish.
 - e) Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed hinge and spring clips.
 - f) Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - g) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- L. Sleeves are not required for core-drilled holes.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 3. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and

- size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Refer to Division 7 Section "Through-Penetration Fire Stop Systems" for materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.14 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.
- D. Install equipment to allow right of way for piping installed at required slope.

END OF SECTION 220500

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Grout.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.

- a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- 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 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 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."

3.2 SLEEVE SCHEDULE

- A. Use sleeves for the following piping-penetration applications:
 1. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.
 2. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 220517

SECTION 220518 – ESCUTCHEONS FOR PLUMBING 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, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. 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, ceilings, and finished floors.
- 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. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
 - i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.

- j. Bare Piping in Equipment Rooms: One-piece, cast-brass type with rough-brass finish.
- k. 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 220518

SECTION 220523 - GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The General Conditions, Special Conditions and Division 1 through Division 32 as set forth in these specifications are hereby incorporated into and shall become a part of the specifications for work under this title, insofar as they apply hereto.
- B. Provide valves to facilitate maintenance and isolation of piping systems.

1.2 QUALITY ASSURANCE

A. STANDARDS

- 1. American National Standards Institute (ANSI), American Society of Mechanical Engineers (ASME), American Society for Testing and Materials (ASTM) and the Manufacturers' Standardization Society of the Valve and Fittings Industry (MSS).
- 2. MSS SP-70-90 Cast Iron Gate Valves, Flanged or Threaded Ends.
- 3. MSS SP-78-92 Cast Iron Plug Valves Flanged and Threaded.
- 4. MSS SP-80-87 Bronze Gate, Globe, and Check Valves.
- 5. MSS SP-85-85 Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.
- 6. MSS SP-110-92 Ball Valves Threaded, Socket-Welded, Solder Joint, Grooved and Flared Ends.

1.3 DEFINITIONS

- A. The following are standard abbreviations for valves:
 - 1. CWP: Cold working pressure.
 - 2. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 3. NBR: Acrylonitrile-butadiene rubber.
 - 4. PTFE: Polytetrafluoroethylene plastic.
 - 5. SWP: Steam working pressure.
 - 6. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

- A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
 2. Protect threads, flange faces, grooves, and weld ends.
 3. Set angle, gate, and globe valves closed to prevent rattling.
 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 5. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use hand wheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. All similar valves used on the project shall be by the same manufacturer.
- B. 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 (1) of the manufacturers specified.

2.2 VALVES, GENERAL

- A. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- B. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- C. Valve Actuators:
1. Chain wheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
 2. Gear Drive: For quarter-turn valves NPS 6 and larger and on discharge of all pumps without VFD's.
 3. Hand wheel: For valves other than quarter-turn types.
 4. Lever Handle: For quarter-turn valves NPS 5 and smaller, except plug valves.
 5. Wrench: For plug valves with square heads. Furnish Owner with one (1) wrench for every ten (10) plug valves, for each size square plug head.
- D. Extended Valve Stems: On insulated valves.
- E. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves; and ASME B16.24 for bronze valves.

- F. Valve Grooved Ends: AWWA C606.
- G. Valve Bypass and Drain Connections: MSS SP-45.

2.3 BALL VALVES (2-1/2 INCHES AND SMALLER)

- A. 400 psi WOG, 150 psi steam, bubble tight against 100 psi, cast bronze body, self-aligning free floating chromium plated bronze or stainless steel ball with full flow port, brass non-rising stem, Teflon seat and body seal, quarter turn operation, solder joint or screwed ends. Valves to include memory stop and stem extensions for insulated piping.
 - 1. Drain valves with hose fitting, dust cover and chain attachment: Apollo No. 78-104
 - 2. All other valves: Apollo No. 77-100/200
 - 3. Manufacturers:
 - a. Apollo (Basis of Design)
 - b. Hammond
 - c. Milwaukee
 - d. Nibco
 - e. Watts

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

- A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, butterfly or gate valves.
 - 2. Throttling Service: Ball or butterfly.

- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

3.3 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full stem movement.
- F. Provide sufficient space to allow adjustment of balancing valves.
- G. Install drain valves in piping at low points and trapped areas to provide complete drainage of all systems.

3.4 JOINT CONSTRUCTION

- A. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated. Open valves before soldering.

3.5 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.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The General Conditions, Special Conditions and Division 1 through Division 32 as set forth in these specifications are hereby incorporated into and shall become a part of the specifications for work under this Section.

1.2 SUMMARY

- A. This Section includes hangers and supports for mechanical system piping and equipment.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the valve and fittings industry.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents and test water.
- B. Design heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents and test water.

1.5 SUBMITTALS

- A. Product Data: For each type of pipe hanger, channel support system component and thermal-hanger shield insert indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer for multiple piping supports and trapeze hangers. Include design calculations and indicate size and characteristics of components and fabrication details.
- C. Welding Certificates: Copies of certificates for welding procedures and operators.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the manufacturers specified:
 - 1. Pipe Hangers:
 - a. Grinnell Corp.
 - b. Michigan Hanger Co., Inc.
 - c. National Pipe Hanger Corp.
 - d. PHD Manufacturing, Inc.

2. Channel Support Systems:
 - a. Grinnell Corp.; Power-Strut Unit.
 - b. Michigan Hanger Co., Inc.; O-Strut Div.
 - c. National Pipe Hanger Corp.
 - d. Thomas & Betts Corp.
 - e. Unistrut Corp.
3. Thermal-Hanger Shield Inserts:
 - a. Michigan Hanger Co., Inc
 - b. Pipe Shields, Inc.
 - c. Rilco Manufacturing Co., Inc.
 - d. Value Engineered Products, Inc.
4. Powder-Actuated Fastener Systems:
 - a. Gunnebo Fastening Corp.
 - b. Hilti, Inc.
 - c. ITW Ramset/Red Head.
 - d. Masterset Fastening Systems, Inc.
5. Roof Pipe Support
 - a. C-Port.
 - b. Mifab
 - c. Advanced Support Products
 - d. Clearline Technologies

2.2 MANUFACTURED UNITS

- A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.
 1. Galvanized, Metallic Coatings: For piping and equipment that will not have field-applied finish.
 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
 1. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- C. Thermal-Hanger Shield Inserts: 100 psi minimum compressive-strength insulation; encased in sheet metal shield.
1. Material for Cold Piping: ASTM C 552, Type I cellular glass with vapor barrier.
 2. Material for Hot Piping: ASTM C 552, Type I cellular glass.
 3. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
 4. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
 5. Insert Length: Extend 2" beyond sheet metal shield for piping operating below ambient air temperature.

2.3 MISCELLANEOUS MATERIALS

- A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- C. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.
- D. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, non-shrink and nonmetallic, dry, hydraulic-cement grout.
 1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
 2. Properties: Nonstaining, noncorrosive, and nongaseous.
 3. Design Mix: 5000-psi 28-day compressive strength.

2.4 ROOF PIPE SUPPORT

- A. Molded recycled rubber support, UV resistant, Maximum 500 pound load, accepts screw fasteners thru pipe clamps, 4" high unit, 2 inch and smaller pipe minimum base size 6" x 9", for 2-1/2 inch and larger pipe minimum base size 6" x 22", maximum support spacing 8 or 10 foot. Provide rigid pipe clamps and stainless steel screws (pipe clamp to be one size larger than piping)

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger requirements are specified in Sections specifying equipment and systems.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.
- C. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 2 to NPS 30.

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
 3. Carbon-or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 5. Adjustable Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated stationary pipes, NPS 3/4 to NPS 2.
 6. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2.
 7. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 2.
 8. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30.
 9. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 10. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36 , with steel pipe base stanchion support and cast-iron floor flange.
 11. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from two (2) rods if longitudinal movement caused by expansion and contraction might occur.
 12. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
 13. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
- D. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F 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 piping installations.
- E. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification 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. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. 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.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where head room is limited.
- F. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi minimum compressive-strength, cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.
- G. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

- B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
 - 1. Field assemble and install according to manufacturer's written instructions.
- C. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.
- D. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, 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.
- E. Install powder-actuated drive-pin fasteners 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.
- F. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- H. Install hangers and supports to allow controlled thermal 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.
- 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 so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.
- K. Insulated Piping: Comply with the following:
 - 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. Include steel weight distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - c. Do not exceed pipe stress limits according to ASME B31.9.
 - 2. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick..

- c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
- d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
- 3. Pipes NPS 8 and Larger: Include wood inserts.
- 4. Insert Material: Length at least as long as protective shield.
- 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
- L. Supports from roof decking systems are not permitted.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.4 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes 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 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 contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

- A. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 220529

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SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The General Conditions, Special Conditions and Division 1 through Division 32 as set forth in these specifications are hereby incorporated into and shall become a part of the specifications for work under this title, insofar as they apply hereto.
- B. Identify by labels and tags the following:
 - 1. Piping and valves exposed in equipment rooms and accessible service areas.
 - 2. Piping and valves running above accessible ceiling construction and near access panels in non-accessible construction areas.
- C. Install laminated plastic markers and metal stamped nameplates for equipment. Provide color banding, flow arrows and contents identification for piping and ductwork.

1.2 SUMMARY

- A. This Section includes the following mechanical identification materials and their installation:
 - 1. Pipe markers.
 - 2. Stencils.
 - 3. Valve tags.
 - 4. Valve schedules.
 - 5. Warning tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Valve numbering scheme.
- D. Valve Schedules: For each piping system. Furnish three extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors and viewing angles of identification devices for piping.

1.5 COORDINATION

- A. Coordination 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 location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. All trades shall use the same type, style and appearance of identification.

PART 2 - PRODUCTS

2.1 PIPING IDENTIFICATION DEVICES

- A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
 - 1. Colors: As indicated in specification schedule.
 - 2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 - 3. Pipes with OD, including insulation, less than 6 inches: Full-band pipe markers extending 360 degrees around pipe at each location.
 - 4. Pipes with OD, including insulation, 6 inches and larger: Either full-band or strip-type pipe markers at least three (3) times letter height and of length required for label.
 - 5. Arrows: A separate unit on each pipe marker to indicate direction of flow.

2.2 VALVE TAGS

- A. Valve Tags: 2" diameter tag stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme, approved by Engineer. Provide 5/32-inch hole for fastener.
 - 1. Material: 16 gauge brass.
 - 2. Valve-Tag Fasteners: Brass beaded chain.

2.3 VALVE SCHEDULES

- A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulation), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
 - 2. Frame: Extruded aluminum.
 - 3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other Division 22 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.
- B. Installing Contractor is responsible for valve tagging, equipment markers and pipe identification of all valves,

equipment and piping on packaged pumping skids.

3.2 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service of each piping system. Install with flow indication arrows showing direction of flow.
- B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed 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 through walls, floors, ceilings, and non-accessible 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 along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings.

C. Pipe Identification

<u>TYPE OF SERVICE</u>	1" BAND	1/2" BAND	<u>DESIGNATION</u>
	<u>COLOR</u>	<u>COLOR</u>	
Domestic Cold Water	Blue	Blue	DCW
Domestic Hot Water	Red	Red	DHW
Domestic Hot Water Return	Red	Red	DHWR
Storm	Yellow	Yellow	STORM
Sanitary	Purple	Purple	SAN
Vent	Purple	Purple	VENT
Gas	Yellow	Yellow	GAS

3.3 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves with captions similar to those indicated in the following:

<u>TYPE OF SERVICE</u>	<u>VALVE TAG DESIGNATION</u>
Domestic Cold Water	DCW
Domestic Hot Water	DHW
Domestic Hot Water Return	DHWR
Gas	GAS

3.4 VALVE-SCHEDULE INSTALLATION

- A. Mount valve schedule on wall in accessible location where directed by Owner. Provide aluminum frame with Plexiglas cover for valve chart.

3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to equipment and other items where required.

3.6 ADJUSTING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work. Stencils, name tags, etc. must be readable from a standing position.
- B. When arrows and letters cannot be stenciled on pipe, stencil identification on 16 gauge aluminum metal panels in correct color and hang panel on piping with key chains.

3.7 CLEANING

- A. Clean faces of mechanical identification devices and glass and frames of valve schedules.

END OF SECTION 220553

SECTION 220700 - PIPE INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The General Conditions, Special Conditions and Division 1 through Division 32 as set forth in these specifications are hereby incorporated into and shall become a part of the specifications for work under this title, insofar as they apply hereto.

1.2 SUMMARY

- A. This Section includes preformed, rigid and flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

1.3 SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details for the following:
 - 1. Application of protective shields, saddles, and inserts at pipe hangers for each type of insulation and hanger.
 - 2. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 3. Removable insulation at piping specialties and equipment connections.
 - 4. Application of field-applied jackets.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread rating of 25 or less; and smoke-developed rating of 50 or less.
- C. ASHRAE Standards: Comply with performance efficiencies prescribed for ASHRAE 90.1, "Energy Efficient Design for New Buildings, Except Low Rise Residential Buildings" for pipe insulation.
- D. No damaged or water soaked insulation shall be used.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields.

- B. Coordinate clearance requirements with piping installer for insulation application.

1.7 SCHEDULING

- A. Schedule insulation application after testing piping systems. Insulation application may begin on segments of piping that have satisfactory test results.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the manufacturers specified.
 - 1. Mineral-Fiber Insulation:
 - a. CertainTeed Manson.
 - b. Knauf FiberGlass GmbH.
 - c. Owens-Corning Fiberglas Corp.
 - d. Schuller International, Inc.

2.2 INSULATION MATERIALS

- A. Cellular-Glass Insulation: Foamed glass rated for 25/50 fire smoke spread, annealed, rigid, hermetically sealed cells, and incombustible. Preformed Pipe Insulation, with Jacket: Comply with ASTM C 552, Type II, Class 2.

2.3 FIELD-APPLIED JACKETS

- A. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil thick, high-impact, ultraviolet-resistant PVC.
 - 1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps and mechanical joints.
 - 2. Adhesive: As recommended by insulation material manufacturer.
 - 3. Rated for 25/50 fire smoke spread if used in return air ceiling plenums.
- B. Glass Cloth Covering: Self-adhesive, mastic impregnated, rewettable cloth on exposed insulation and fittings only.
 - 1. Thickness: 0.028 inches
 - 2. Maximum Service Temperature: 450 degrees F.
 - 3. Density: 14.3 oz/sq yd
 - 4. Surface Burning Characteristic: 25/50 per ASTM E84

2.4 ACCESSORIES AND ATTACHMENTS

- A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave pre-sized a minimum of 14.3 oz/sq. yd.

1. Tape Width: 4 inches.

2.5 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.
- E. Apply 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. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- H. Keep insulation materials dry during application and finishing.
- I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- J. Apply insulation with the least number of joints practical.
- K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.
- L. Hangers and Anchors:
 1. Apply insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound

recommended by the insulation material manufacturer to maintain vapor retarder.

3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.
- M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.
- O. Apply insulation with integral jackets as follows:
1. Pull jacket tight and smooth.
 2. Circumferential Joints: Cover with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
 3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply 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 o.c.
 - a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.
 4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
 5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.
- P. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.
- Q. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.
- R. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.
 1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Fire Stopping."
- S. Floor Penetrations: Apply insulation continuously through floor assembly.
 1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

3.4 CELLULAR-GLASS INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
1. Secure each layer of insulation to pipe with wire, tape, or bands without deforming insulation materials.
 2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic.
 3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
5. All exposed ends for cellular-glass insulation shall be neatly trimmed and beveled. All exposed insulation material shall be covered with mastic.

3.5 FIELD-APPLIED JACKET APPLICATION

- A. Apply aluminum metal jacket for all exterior water piping, with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal joints with weatherproof sealant recommended by insulation cover manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
- B. Apply glass-cloth jacket, for piping that is exposed in finished areas and mechanical room areas directly over insulation and fittings with factory-applied jackets.
 1. Apply jacket smooth and tight to surface with 1-inch overlap at seams and joints.
 2. Embed glass cloth between two (2) 0.062-inch thick coats of jacket manufacturer=s recommended adhesive.
 3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.
- C. Provide PVC fitting covers for all exposed piping that is to be insulated.

3.6 PIPING SYSTEM APPLICATIONS

- A. Materials and thicknesses for systems listed below are specified in schedules within this section.
- B. Insulate the following piping systems:
 1. Insulate hot water supply and return piping with glass fiber insulation.
 2. Insulate city water supply piping with glass fiber insulation.
 3. Insulate storm piping with glass fiber insulation.
- C. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
 1. Flexible connectors.
 2. Vibration-control devices.
 3. Below-grade piping, unless otherwise indicated.
 4. Chrome-plated pipes and fittings, unless potential for personnel injury.
 5. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

D. Minimum Insulation Thickness For Pipe Sizes:

FLUID PIPING SYSTEM TYPES	TEMPERATURE RANGES (DEG. F)	LESS THAN 1" (INCHES)	1" TO 1-1/4" (INCHES)	1-1/2" TO 3" (INCHES)	4" AND LARGER (INCHES)
Hot Water	Any	1.0	1.0	1.5	1.5
City Water	Any	1.0	1.0	1.0	1.0
Hot Water Return	Any	1.0	1.0	1.5	1.5
Horizontal storm	Any	1.0	1.0	1.0	1.0
Roof Drain sumps	Any	1.0	1.0	1.0	1.0

NOTE: The minimum listed thickness is based on a minimum R value of 4.6. Thickness to vary if the insulation R value is different than 4.6. In addition, the minimum thickness is to be increased as required to meet ASHRAE 90.1.

E. Insulation at fire walls: All insulated piping penetrating walls with a fire resistive rating shall be insulated with molded foamglass; "ASJ-SSL" covering with a dual purpose fireproof, kraft aluminum foil, laminated white jacket. Insulation to be of same thickness as adjoining insulation.

F. PIPE INSULATING SUPPORT

1. On insulated piping with pipe supports around outside of covering provide galvanized steel formed bearing plates. Plates to be lined with length of foam glass insulation.
 - a. 8" and smaller pipe: 12" long, 12 gauge plate
 - b. 10" and larger pipe: 24" long, 10 gauge plate

3.7 FIELD QUALITY CONTROL

A. Insulation applications will be considered defective if sample inspection reveals noncompliance with requirements. Remove defective Work and replace with new materials according to these Specifications.

END OF SECTION 220700

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The General Conditions, Special Conditions and Division 1 through Division 32 as set forth in these specifications are hereby incorporated into and shall become a part of the specifications for work under this section.
- B. Provide a complete system of hot water and cold water to fixtures.
- C. Install and make connection to all faucets.
- D. Sterilize complete domestic water system.

1.2 SUBMITTALS

- A. Product Data: For pipe, tube, fittings and couplings.
- B. Water Samples: Specified in Part 3 "Cleaning" Article.
- C. Field quality-control test reports.

1.3 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp or other markings of specified testing agency.
- B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.
- C. Standards:
 - 1. American National Standards Institute (ANSI)
 - 2. American Society for Testing and Materials (ASTM)
 - 3. American Water Works Association (AWWA)
 - 4. National Sanitation Foundation (NSF)
 - 5. Plumbing and Drainage Institute (PDI)

PART 2 - PRODUCTS

2.1 WATER PIPING, BELOW GRADE

- A. Copper Tubing: ASTM B88; or ASTM B251; Type M, hard drawn. (Exterior and interior underground)
 - 1. Fittings: ASME B16, 18, cast copper alloy, or ASME B16.22, wrought copper and bronze, brazed joint, pressure type.
 - 2. Joints: AWS A5.8 Classification BCuP-3 or BCuP-4 silver braze or ASTM B32.

2.2 WATER PIPING, ABOVE GRADE

- A. Copper Tubing: ASTM B88, Type L for sizes 4 inches and smaller.
 - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.
 - 2. Joints: Solder, lead free, ASTM B32, 95-5 tin- antimony, or tin and silver, with melting range 430 to 435 degrees F.
 - 3. Flanges: Bronze
 - 4. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.3 FLANGES, UNIONS AND COUPLINGS

- A. Pipe Size 2 Inches and Under:
 - 1. Ferrous Pipe: 150 psig malleable iron threaded unions.
 - 2. Copper tube and pipe: 150 psig bronze unions with soldered joints.
- B. Pipe Size Over 2 Inches:
 - 1. Ferrous Pipe: 150 psig forged steel slip-on flanges; 1/16 inch thick preformed neoprene gaskets.
 - 2. Copper tube and pipe: 150 psig slip-on bronze flanges; 1/16 inch thick preformed neoprene gaskets.
- C. Dielectric Connections: Flanges with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.4 BALL VALVES – 150 PSIG

- A. Bronze Manufacturers:
 - 1. Watt Model B6001
 - 2. Other acceptable manufacturers offering equivalent products:
 - a. Hammond Model 8511
 - b. Apollo Model 70-100/200
 - c. Nibco 585
- B. Up to and including 2 inches: Bronze two piece body, chrome plated brass or stainless ball, teflon seats and stuffing box ring, lever handle, solder or threaded ends with union.
- C. Over 2 Inches: Cast steel body, chrome plated steel or stainless ball, Teflon seat and stuffing box seals, lever handle flanged.

2.5 BUTTERFLY VALVES – 150 PSIG

- A. Manufacturers:
 - 1. Watt Model DBF03.
 - 2. Other acceptable manufacturers offering equivalent products:
 - a. Grinnell, LC-8201
 - b. Keystone, AR2
 - c. Hammond, 6201
 - d. Centerline 200
 - e. Demco NE-C
- B. Cast or ductile iron body, chrome or nickel plated ductile iron disc, resilient replaceable EPDM seat, lug ends for dead end service, extended neck, 10 position level handle.

2.6 SWING CHECK VALVES – 150 PSIG

- A. Manufacturers:
 - 1. William Powell Model 560Y, 559
 - 2. Other acceptable manufacturers offering equivalent products:
 - a. Hammond Model IB944, IR1124
 - b. Stockham Model B-321, G-931
 - c. Nibco Model S-433-B, F918-B
 - d. Watts B-5001T, F-511
- B. Up to and including 2 inches: Bronze swing disc, solder ends.
- C. Over 2 Inches: Iron body, bronze trim, swing disc, renewable disc and seat, flanged ends.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Excavating, trenching, and backfilling are specified in Division 31.
- B. Flanges may be used on aboveground piping, unless otherwise indicated.

3.2 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use bronze ball valves for piping NPS 3 and smaller. Use cast-iron butterfly valves with

flanged ends for piping NPS 4 and larger.

2. Throttling Duty: Use balancing valves for piping NPS 2-1/2 and smaller.
 3. Drain Duty: Hose-end drain valves.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops.
- C. Install drain valves for equipment at base of water riser, at low points in horizontal piping and where required to drain water piping.
1. Install hose-end drain valves at low points in water mains, risers and branches.
 2. Install stop-and-waste drain valves where indicated.

3.3 PIPING INSTALLATION

- A. Provide piping materials as listed in part 2 of this specification section.
- B. Install domestic water piping level.
- C. Where water lines drop in outside walls, install piping so that the wall insulation is between the pipe and the outside wall.
- D. Coordinate installation height of faucets, hose bibbs, and wall hydrants and Owner's Representative.
- E. Unless otherwise noted, install shock absorbers at the end of each main branch and at the end of all water closet and urinal branches.
- F. Install dielectric unions between piping of dissimilar metals.
- G. Install a union between valves and final connections to all items of equipment.
- H. All soldering shall be done with propane torch. Oxy-Actylene is prohibited.
- I. Nipples shall be of the material as the pipe with which they are used.
- J. Install a check valve on all equipment with a hot and cold mixing valve.
- K. Place plugs in ends of uncompleted piping at end of day and when work stops.
- L. All pipes to be protected from debris entry.

3.4 JOINT CONSTRUCTION

- A. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder and ASTM B 828 procedure, unless otherwise indicated. Open valves before soldering.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Pipe hanger and support devices are specified in Division 230529 Section "Hangers and Supports for HVAC Piping and Equipment." Install the following:
1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 2. Individual, Straight, and Horizontal Piping Runs: According to the following:

- a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one (1) size for double-rod hangers, to a minimum of 3/8".
- D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 and Smaller: 60" with 3/8" rod.
 2. NPS 1 and NPS 1-1/4: 72" with 3/8" rod.
 3. NPS 1-1/2 and NPS 2: 96" with 3/8" rod.
 4. NPS 2-1/2: 108" with 1/2" rod.
 5. NPS 3 to NPS 5: 120" with 1/2" rod.
 6. NPS 6: 120" with 3/4" rod.
- E. Install supports for vertical copper tubing every 10'-0".

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.

3.7 FIELD QUALITY CONTROL

- A. Inspect domestic water piping as follows:
 1. Do not enclose, cover or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 2. 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:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- B. Test domestic water piping as follows:
1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 2. Test for leaks and defects in new piping. If testing is performed in segments, submit separate report for each test complete with diagram of portion of piping tested.
 3. Leave domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 4. Cap and subject piping to static water pressure of 150 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four (4) hours. Leaks and loss in test pressure constitute defects that must be repaired.
 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.

3.8 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. Open throttling valves to proper setting.
 4. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
 5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 6. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 7. Check plumbing specialties and verify proper settings, adjustments and operation.

3.9 STERILIZATION OF WATER LINES

- A. After water piping is complete and fixtures have been installed, flush piping clean and sterilize all new hot and cold water piping. The sterilization shall be done by a Water Testing Laboratory regularly engaged in the service. All fees for testing and use of testing equipment shall be paid by this Contractor.
- B. With all outlets closed, fill system to working pressure and close valve on supply main.
- C. Open all fixtures slightly and pump a sterilization solution into test tap as follows; 400 minimum to 1000 maximum parts per million chlorine solution made from a sanitation grade of hyperchlorite, 70% available chlorine. Hyperchlorites may be either Pittchlor, H.T.H. or Perclorn.
- D. Each outlet, hot or cold, shall be tested during fill to prove the presence of chlorine at that outlet and shall be opened and closed several times. Chlorine shall be present at all outlets.

- E. Water piping system shall remain filled for a period of 24 hours and each outlet shall be again tested and shall have at least 100 parts per million of chlorine remaining.
- F. All outlets shall be opened wide and the main supply valves opened, flushing system free of chlorine with clean water. Outlets shall be again checked and flushed until free of chlorine. Residual chlorine shall not be greater than 0.2 parts per million or until approved by the State Health Department. Flush main valves and entire system.
- G. After final flushing, all aerators shall be removed, cleaned and replaced.
- H. Chlorination of the system may be performed at same time the pressure test is conducted.
- I. Sterilization procedures shall be witnessed by the Architect, city and health officials and the Owner's Representative.
- J. After sterilization of system is complete, provide the Owner with written certification from an outside testing agency certified in this manner of testing of sterility and confirmation that piping is clean and safe to transmit water fro human consumption.

END OF SECTION 221116

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SECTION 221316 – SANITARY WASTE VENT SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide a complete system of soil, waste, and vent piping to fixtures, including traps, within building.

1.2 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.3 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Flexible Transition Couplings for Underground Non-pressure Piping: ASTM C 1173 with elastomeric sleeve. Include ends of same sizes as piping to be joined and include corrosion-resistant metal band on each end.

2.2 CAST-IRON SOIL PIPING

- A. Hub-and-Spigot Pipe and Fittings: ASTM A 74, Service class.
 - 1. Gaskets: ASTM C 564, rubber.

2.3 COPPER TUBING

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
 - 1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 2 for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.
- B. Sanitary soil, waste and vents.
 - 1. Underground soil and waste to 5'-0" outside of building:
 - a. Pipe: Service weight cast iron hub and spigot pipe
 - b. Fittings: Cast iron to match pipe
 - 2. Aboveground Soil, Waste and Vents:
 - a. Soil, NPS 2-1/2 and smaller serving urinals only.
 - 1) Pipe: Type "K" copper.
 - 2) Fittings: Wrought copper DWV fittings with soldered joints.
 - b. All other soil, waste and vents, NPS 2 and smaller:
 - 1) Pipe: Type L copper
 - 2) Fittings: Wrought copper DWV fittings with soldered joints
 - c. Soil, waste and vent, NPS 2-1/2 and larger:
 - 1) Pipe: Service weight cast iron no-hub pipe with heavy duty stainless steel couplings
 - 2) Fittings: Cast iron to match pipe

3.3 PIPING INSTALLATION

- A. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- B. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.
- C. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- D. 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 (2) 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.
- E. 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.
- F. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Building Sanitary Drain: 2% downward in direction of flow for piping NPS 3 and smaller; 1% downward in direction of flow for piping NPS 4 and larger.
 2. Horizontal Sanitary Drainage Piping: 2% downward in direction of flow.
 3. Vent Piping: 1% down toward vertical fixture vent or toward vent stack.
- G. Minimum size for underground soil, waste and vent piping is 2".
- H. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- I. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

- A. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
 2. Hubless Joints: Make with rubber gasket and sleeve or clamp.
- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Refer to Division 220529 Section "Hangers and Supports For Plumbing Piping and Equipment" for pipe hanger and support devices. Install the following:
1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support vertical piping at base and at each floor.
- C. Rod diameter may be reduced one (1) size for double-rod hangers, with 3/8" minimum rods.
- D. 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: | 60" with 3/8" rod. |
| 2. NPS 3: | 60" with 1/2" rod. |
| 3. NPS 4 and NPS 5: | 60" with 5/8" rod. |

4. NPS 6: 60" with 3/4" rod.
5. Spacing for 10-foot lengths may be increased to 10'-0". Spacing for fittings is limited to 60".
- E. Install supports for vertical cast-iron soil piping every 15'-0".
- F. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/4: 72" with 3/8" rod.
- G. Install supports for vertical copper tubing every 10'-0".
- H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. 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 Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

3.7 VENTS

- A. Install Vents Through Roof As Follows:
 1. 3" minimum size and extended a minimum of 12" above the roof.
 2. Locate at least 8'-0" away from outside wall of building, 15'-0" away from outside air intakes or operable windows, and 2'-0" away from roof flashing work.
 3. Offset vent piping to allow for thermal expansion and contraction.
 4. Vent flashing to extend at least 12" from vent pipe, clamp between roofing and extend up, over and turn down inside vent pipe.

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 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. 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. Introduce air into piping system equal to pressure of 1" wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 - 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

- 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.

END OF SECTION 221316

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SECTION 221413 - FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Conditions, Special Conditions and Division 1 through Division 32 as set forth in these specifications are hereby incorporated into and shall become a part of the specifications for work under this title, insofar as they apply hereto

1.2 SUMMARY

- A. This Section includes the following storm drainage piping inside the building:
 - 1. Pipe, tube, and fittings.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. LLDPE: Linear, low-density polyethylene plastic.
- C. PE: Polyethylene plastic.
- D. PVC: Polyvinyl chloride plastic.
- E. TPE: Thermoplastic elastomer.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with the following minimum working pressure ratings, unless otherwise indicated:
 - 1. Storm Drainage Piping: 10-foot head of water.

1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.
- C. Standard: State Environmental Protection Agency

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

- A. Cellular-Core, Sewer and Drain Series, PVC Pipe: ASTM F 891, Series PS 100.
 - 1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Series PS 100 sewer and drain pipe.
- B. Solvent Cement and Adhesive Primer:
 - 1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 for excavating, trenching, and backfilling.

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. Install gravity-flow, non-pressure, 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 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 30 inch minimum cover.
- F. 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.

- G. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. 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 storm 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. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

3.4 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.
 - 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 storm drainage 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 storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Test Procedure: Test storm drainage piping 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. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 5. Prepare reports for tests and required corrective action.
- E. Clean interior of piping. Remove dirt and debris as work progresses.

- F. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- G. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 221413

SECTION 221423 - STORM SEWER SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The General Conditions, Special Conditions and Division 1 through Division 32 as set forth in these specifications are hereby incorporated into and shall become a part of the specifications for work under this project.

1.2 SUMMARY

- A. SCOPE OF WORK

- 1. Provide all storm drainage piping system for interior of the building.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with the following minimum working pressure ratings, unless otherwise indicated:

- 1. Storm Drainage Piping: 10-foot head of water.

1.4 SUBMITTALS

- A. Product Data: For pipe, tube, fittings and couplings.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Standard: State Environmental Protection Agency.

PART 2 - PRODUCTS

2.1 STORM WATER PIPING, BURIED INTERIOR OF BUILDING

- A. Cast Iron Pipe: ASTM A74 service weight
 - 1. Fittings: Hub-and-Spigot.
 - 2. Joints: Gaskets: ASTM C 564, rubber..

2.2 STORM WATER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: CISPI 301, hubless, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: Neoprene gaskets and 304 stainless steel clamp-and wide shield assemblies. Joints bonded with Gilman adhesive lubricant and rodded per CISPI 1994.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 for excavating, trenching and backfilling.

3.2 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.

3.3 PIPING INSTALLATION

- A. Provide piping materials as listed in part 2 of this specification section.
- B. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers.
- C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.
- D. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- E. Make changes in direction for storm piping using appropriate branches, bends and long-sweep bends. 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.
- F. Lay buried building drain 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.
- G. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Storm Drain: 1 percent downward in direction of flow for piping.
 - 2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.
- H. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- I. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

- A. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings" and manufacturer's recommendations."
 - 1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
 - 2. Hubless joints: Make with rubber gasket and sleeve or clamp.
 - 3. Grooved End: To be assembled per manufacturer's instructions.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Refer to Division 23 Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- D. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and 2 NPS: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 - 4. NPS 6: 60 inches with 3/4-inch rod.
 - 5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
- E. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
- D. Extend storm drainage piping with downspout boots from each downspout, as indicated on drawings.

3.7 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.
 - 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 storm drainage piping according to procedures of authorities having jurisdiction, or in absence of published procedures, as follows:
 - 1. Test for leaks and defects in piping. 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, storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Test Procedure: Test storm drainage 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. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 5. Prepare reports for tests and required corrective action.

3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses. Flush lines as required to remove collected debris.
- 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.

END OF SECTION 221413

SECTION 221424 – NATURAL GAS SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The General Conditions, special Conditions and Division 1 through Division 32 as set forth in these specifications are hereby incorporated into and shall become a part of the specifications for work under this title, insofar as they apply hereto.
- B. Provide natural gas piping and valve to new HVAC equipment on roof. Connections per code and equipment by the Plumbing Contractor.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Piping Valves: Include pressure rating, capacity and settings.
 - 2. Pressure Regulators: Include pressure rating, capacity and settings of selected models.
- B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- C. Maintenance Data: For natural gas specialties and accessories to include in maintenance manuals specified in Division 1.

1.3 QUALITY ASSURANCE

- A. Electrical Components and Devices: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AGA Standard: Comply with American Gas Association International Fuel Gas Code.
- C. UL Standard: Provide components listed in UL's "Gas and Oil Equipment Directory" if specified to be UL listed.

PART 2 - PRODUCTS

2.1 FUEL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Steel Pipe: ASTM A53, Schedule 40 black.
 - 1. Fittings: ASTM A234, forged steel welding type, with AWWA C105 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.
 - 2. Joints: ANSI B31.9, welded.

2.2 FUEL GAS PIPING, ABOVE GRADE

- A. All gas piping and fittings, 1 psig and greater to be welded.
- B. Steel Pipe: ASTM A53 Grade B, Schedule 40 black:
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234, forged steel welding type.
 - 2. Joints: NFPA 54, threaded or welded to ANSI B31.9.

3. Unions: 300 pound malleable iron, located downstream of appliance valve only.
4. Flanges: 150 pound forged steel ASTM A105, welded neck or slip-on ANSI B16.5.
5. Gaskets: 1/16 inch thick preformed neoprene gasket.
6. All exterior piping to be primed and epoxy painted per specification section 099113.

2.3 FLANGES, UNIONS, AND COUPLINGS

- A. Pipe size 2 inches and under:
 1. Ferrous Pipe: 150 psig malleable iron threaded unions.
- B. Pipe size over 2 inches:
 1. Ferrous Pipe: 150 psig forged steel slip-on flanges; 1/16 inch thick preformed neoprene gaskets.

2.4 PLUG VALVES

- A. Manufacturers:
 1. Homestead Model 601.
 2. Resun
 3. Apollo Valves.
 4. Grinnell Corp.
 5. Milwaukee Valve Company, Inc.
 6. Mueller Company; Mueller Gas Products Division
 7. Nibco, Inc.
 8. Hammond.
 9. Rockwell.
- B. Iron Body Plug Valve; threaded ends, up to and including 4 inches:
 1. Iron body, bronze tapered plug, lubricated, threaded ends.
 2. Rated for 200 CWP, AGA and UL listed.
 3. Operator: One plug valve wrench for every ten plug valves, minimum of one.
- C. Bronze Body Plug Valve; threaded ends, up to and including 4 inches:
 1. Bronze body, bronze tapered plug, non-lubricated, Teflon packing, threaded ends.
 2. Rated for 200 CWP, AGA and UL listed.

3. Operator: One plug valve wrench for every ten plug valves, minimum of one.
- D. Iron Body Plug Valve; flanged ends, over 2 inches:
1. Cast iron body and plug, full port opening, pressure lubricated, Teflon packing, flanged ends.
 2. Rated for 200 CWP, AGA and UL listed.
 3. Operator: Each plug valve with a wrench with set screw.
- E. Iron Body Plug Valve; flanged ends, over 2 inches, Teflon sleeve lined, D.I. body:
1. Cast iron body and plug, non-lubricated, Teflon packing, flanged ends.
 2. AGA and UL listed.
 3. Operator: Each plug valve with a wrench with set screw.

2.5 BALL VALVES

- A. Manufacturers:
1. Homestead Model 601.
 2. Resun
 3. Apollo Valves.
 4. Grinnell Corp.
 5. Milwaukee Valve Company, Inc.
 6. Mueller Company; Mueller Gas Products Division
 7. Nibco, Inc.
 8. Hammond.
 9. Rockwell.
- B. Bronze Ball Valve; threaded ends, up to and including 2 inches:
1. Bronze, two piece body, chrome plated brass ball and brass stem, Teflon seats and stem packing, lever handle, threaded ends.
 2. Rated for 600 psi WOG
 3. AGA, UL listed for natural gas.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.

- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient.
- D. Install piping to conserve building space and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Provide clearance for installation of insulation and access to valves and fittings.
- H. Provide access where valves and fittings are not exposed.
- I. Provide firm bed for each pipe of minimum of 6 inches of bank run gravel. Support pipe uniformly.
- J. Provide steel pipe sleeve for each pipe that passes under each footing or grade beam. Extend sleeve not less than 18 inches from footing with not less than 2 inches clearance around pipe. Backfill with concrete not less than 6 inches around sleeve and up to bottom of footing or grade beam.
- K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- L. Provide support for utility meters in accordance with requirements of utility companies.
- M. Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting.
- N. Install valves with stems upright or horizontal, not inverted.

3.3 PIPING INSTALLATION

- A. Concealed Locations: Install gas piping per the following:
 - 1. Vent conduit to outside and terminate with screened vent cap.
 - 2. Above ceiling locations: Welded gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves or unions above return air ceiling plenums.
 - 3. In partitions: Do not install concealed piping in solid partitions. Exception: Piping passing through partitions or walls.
 - 4. Prohibited Locations: Do not install gas piping in or through circulating air ducts, chutes, chimneys or gas vents (flues), ventilating ducts, and elevator shafts.

5. Install piping under slab (science classrooms), in conduit made of wrought iron, plastic pipe, steel pipe, or other approved conduit material per international fuel gas code. Install conduit at least 2" above finished floor.
- B. Drips and Sediment Traps: Install drips at points where condensate may collect. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.
 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum length nipple of three (3) pipe diameters, not less than 3" long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.
- C. 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.
- D. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- E. Connect branch piping from top or side of horizontal piping.
- F. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
- G. Install flanges on valves, specialties, and equipment having NPS 2 1/2" and larger connections.
- H. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned down reducing elbow fittings with corrosion resistant insect screens in large end.

3.4 JOINT CONSTRUCTION

- A. Use materials suitable for fuel gas.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Refer to Division 230529 Section "Hangers and Supports for HVAC Piping and Equipment" for pipe hanger and support devices.
- B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 1. NPS 1 and Smaller: 96" with 3/8" rod
 2. NPS 1-1/4: 108" with 3/8" rod
 3. NPS 1-1/2 and NPS 2: 108" with 3/8" rod
 4. NPS 2-1/2 to NPS 3-1/2": 120" with 1/2" rod
 5. NPS 4 and NPS 5: 120" with 5/8" rod
 6. NPS 6: 120" 3/4" rod

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of fuel gas piping, fittings, and specialties.
- B. Install piping adjacent to appliances to allow service and maintenance.

- C. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72" of each appliance. Install union downstream from valve.
- D. Sediment Traps: Install tee fitting with capped 6" long nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.
- E. Ground Equipment:
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque valves are not indicated, use those specified in UL 486A and UL 486B.
 - 2. Do not use gas pipe as grounding electrode.

3.7 PAINTING

- A. Painting by Contractor.

3.8 FIELD QUALITY CONTROL

- A. Inspect, test and purge piping according to ANSI Z223.1, Part 4 "Inspection, Testing and Purging" and requirements of the local utilities company or authorities having jurisdiction.
- B. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.
- C. Report test results promptly and in writing to Architect and authorities having jurisdiction.
- D. Verify capacities and pressure ratings of service meters, pressure regulators, valves and specialties.
- E. Verify correct pressure settings for pressure regulators.
- F. Verify that specified piping tests are complete.

3.9 ADJUSTING

- A. Adjust controls and safety devices. Replace damaged and malfunctioning controls and safety devices.

END OF SECTION 221424

SECTION 221425 - FACILITY NATURAL-GAS PIPING

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. Piping.
 - 2. Piping specialties.
 - 3. Valves.
 - 4. Pressure regulators.

1.3 DEFINITIONS

- A. Site gas piping system.

1.4 SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Piping.
 - 2. Piping specialties.
 - 3. Valves. Include pressure rating, capacity, settings and electrical connection data of selected models.
 - 4. Pressure regulators. Indicate pressure ratings and capacities.
 - 5. Dielectric fittings.
- 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.

1.5 QUALITY ASSURANCE

- A. Electrical Components and Devices: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AGA Standard: Comply with American Gas Association International Fuel Gas Code.
- C. UL Standard: Provide components listed in UL's "Gas and Oil Equipment Directory" if specified to be UL listed.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.7 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
 - 1. Notify Owner's Representative no fewer than two days in advance of proposed interruption of natural-gas service.
 - 2. Do not proceed with interruption of natural-gas service without Owner's Representative written permission.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 FUEL GAS PIPING BURIED BEYOND 5 FEET OF BUILDING

- A. Polyethylene Pipe: ASTM D2513, SDR 11.5, or as approved by local utility company.
 - 1. Fittings: ASTM D2683 or ASTM D2513 socket type.
 - 2. Joints: Fusion welded.
 - 3. Trace Wire: Copper #12 AWG insulated, taped to pipe.

2.2 FUEL GAS PIPING BURIED WITHIN 5 FEET OF BUILDING TO ABOVE GRADE

- A. Steel Pipe: ASTM A53, Schedule 40 black.
 - 1. Fittings: ASTM A234, forged steel welding type, with AWWA C105 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.
 - 2. Joints: ANSI B31.9, welded.

2.3 PIPING SPECIALTIES

- A. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.4 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.5 PLUG VALVES

- A. Manufacturers:
 - 1. Homestead Model 601.
 - 2. Resun
 - 3. Apollo Valves.
 - 4. Grinnell Corp.
 - 5. Milwaukee Valve Company, Inc.
 - 6. Mueller Company; Mueller Gas Products Division
 - 7. Nibco, Inc.
 - 8. Hammond.
 - 9. Rockwell.
- B. Iron Body Plug Valve; threaded ends, up to and including 4 inches:
 - 1. Iron body, bronze tapered plug, lubricated, threaded ends.
 - 2. Rated for 200 CWP, AGA and UL listed.
 - 3. Operator: One plug valve wrench for every ten plug valves, minimum of one.
- C. Bronze Body Plug Valve; threaded ends, up to and including 4 inches:
 - 1. Bronze body, bronze tapered plug, non-lubricated, Teflon packing, threaded ends.
 - 2. Rated for 200 CWP, AGA and UL listed.
 - 3. Operator: One plug valve wrench for every ten plug valves, minimum of one.
- D. Iron Body Plug Valve; flanged ends, over 2 inches:
 - 1. Cast iron body and plug, full port opening, pressure lubricated, Teflon packing, flanged ends.
 - 2. Rated for 200 CWP, AGA and UL listed.

3. Operator: Each plug valve with a wrench with set screw.
- E. Iron Body Plug Valve; flanged ends, over 2 inches, Teflon sleeve lined, D.I. body:
1. Cast iron body and plug, non-lubricated, Teflon packing, flanged ends.
 2. AGA and UL listed.
 3. Operator: Each plug valve with a wrench with set screw.

2.6 BALL VALVES

- A. Manufacturers:
1. Homestead Model 601.
 2. Resun
 3. Apollo Valves.
 4. Grinnell Corp.
 5. Milwaukee Valve Company, Inc.
 6. Mueller Company; Mueller Gas Products Division
 7. Nibco, Inc.
 8. Hammond.
 9. Rockwell.
- B. Bronze Ball Valve; threaded ends, up to and including 2 inches:
1. Bronze, two piece body, chrome plated brass ball and brass stem, Teflon seats and stem packing, lever handle, threaded ends.
 2. Rated for 600 psi WOG
 3. AGA, UL listed for natural gas.

2.7 GAS PRESSURE REGULATING VALVE

- A. Manufacturers:
1. Homestead Magnatrol
 2. Fisher
 3. Resun
 4. Equimeter Inc.
 5. Mueller Company; Mueller Gas Products Division

6. Watts Industries, Inc.
 - B. Fully adjustable direct operated pressure reducing regulator, steel body class 150, neoprene gasket, stainless steel trim, and vent assembly or connection per code.
 - C. Regulating valves:
 1. Gas pressure regulators for main gas service per the requirements of the Local Gas Utility Company.
 2. Gas pressure regulator for emergency generator furnished by the Electrical Contractor (generator supplier), per contract documents. Installed by the Plumbing Contractor per contract document at the generator. Regulator inlet emergency pressure rated for 1 psig minimum. Plumbing contractor to extend the regulator vent to above the generator and terminate with a vent cap if required and provide inlet shut-off valve and discharge pressure gauge.

2.8 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to NFPA 54 and the local Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 and the local Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

- A. Provide piping materials as listed in part 2 of this specification section.
- B. Comply with NFPA 54 and the local Fuel Gas Code for installation and purging of natural-gas piping.
- C. Install underground, natural-gas piping buried at least 30 inches below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- D. Install underground, PE, natural-gas piping according to ASTM D 2774.
- E. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal and protect joints.
 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 3. Replace pipe having damaged PE coating with new pipe.
- F. Install fittings for changes in direction and branch connections.

3.4 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install anode for metallic valves in underground PE piping.

3.5 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:
1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 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.
- E. Flanged Joints: Install gasket material, size, type and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- F. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
1. Plain-End Pipe and Fittings: Use butt fusion.

2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.6 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

3.7 LABELING AND IDENTIFYING

- A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.8 PAINTING

- A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel (flat).
 - d. Color: Gray.
- C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 1. Test, inspect and purge natural gas according to NFPA 54 and the Local Fuel Gas Code and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain earthquake valves.

3.11 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping shall be one of the following:
 - 1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
 - 2. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
- B. 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.

3.12 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL. Subject to local utility company requirements.
- B. Underground:
 - 1. PE valves.
 - 2. NPS 2 and Smaller: Bronze plug valves.
 - 3. NPS 2-1/2 and Larger: Cast-iron, lubricated plug valves.

3.13 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following: Subject to local utility company requirements.
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
- B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
 - 3. Cast-iron, nonlubricated plug valve.
- C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
- D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.

2. Bronze plug valve.
 3. Cast-iron, lubricated plug valve.
- E. Valves in branch piping for single appliance shall be one of the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.
 2. Bronze plug valve.

END OF SECTION 231123

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SECTION 221430 – PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The General Conditions, Special Conditions and Division 1 through Division 32 as set forth in these specifications are hereby incorporated into and shall become a part of the specifications for work under this title, insofar as they apply hereto.
- B. Provide plumbing piping specialties or accessories as required by either the Equipment Manufacturer or the Local Code Authority.

1.2 QUALITY ASSURANCE

A. STANDARDS

- 1. Plumbing and Drainage Institute (PDI), American Society of Sanitary Engineering (ASSE), American National Standards Institute (ANSI).

1.3 PERFORMANCE REQUIREMENTS

Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:

- 1. Domestic Water Piping: 125 psig.
- 2. Sanitary Waste and Vent Piping: 10-foot head of water.

1.4 SUBMITTALS

- A. Submit per the provisions of section 220500
- B. Product Data: Include rated capacities and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following:
 - 1. Thermostatic water mixing valves and water tempering valves.
 - 2. Water hammer arresters, air vents, and trap seal primer valves and systems.
 - 3. Cleanouts, floor drains, and roof drains.
 - 4. Sleeve penetration systems.
- C. Maintenance Data: For plumbing specialties to include in maintenance manuals. Include the following:
 - 1. Thermostatic water mixing valves and water tempering valves.
 - 2. Trap seal primer valves and systems.

1.5 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of plumbing specialties and are based on the specific system indicated. Refer to Division 1, Section "Product Requirements."
- B. Plumbing specialties shall bear label, stamp, or other markings of specified testing agency.

- 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. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.
- E. NSF Compliance:

Comply with NSF 61, "Drinking Water System Components--Health Effects, Sections 1 through 9," for potable domestic water plumbing specialties.

1.6 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 per the requirements of section 220500.
- B. Operating Key Handles: Equal to 100 percent of amount installed for each key operated hose bibb and hydrant installed.

PART 2 – PRODUCTS

2.1 SPECIALTIES SCHEDULED ON THE DRAWINGS

- A. Overflow Drains
 - a. Refer to Schedule on Drawings.

2.2 SHOCK ABSORBERS

- A. Shock absorbers shall conform to ASSE Standard 1010. Furnish shock absorbers as shown on the Drawings. Shock absorbers shall be selected by weight in fixture units per manufacturers recommendations.
- B. Manufacturers:
 - 1. Amtrol "Diatrol"
 - 2. Josam
 - 3. J.R. Smith
 - 4. Precision Plumbing Products

2.3 CLEANOUTS

- A. Manufacturers:
 - 1. Josam
 - 2. Smith (Basis of Design)
 - 3. Watts
 - 4. Zurn
- B. All cleanouts to be line size up to and including 4" and 4" for all larger pipes and shall be installed in accessible locations.

- C. Wall mounted cleanouts shall be Smith No. 4532S with DUCO cast iron tee, tapered thread bronze "T" handle countersunk plug, no-hub outlet, stainless steel round cover with vandal proof screw.
- D. Cleanouts in vertical pipe shall be Smith No. 4512S with Duco cast iron tee, tapered thread bronze countersunk plug, no hub outlet, stainless steel round cover with vandal proof screw.
- E. Cleanouts in horizontal piping shall be Smith No. 4420C Duco cast iron spigot ferrule with cast bronze, tapered thread countersunk plug installed on Wyes or T-Wyes.
- F. Cleanouts in finished floors shall be Smith No. 4023S DUCO cast iron cleanout with round adjustable secured nickel bronze vandal proof top, no hub outlet and cast bronze tapered thread countersunk plug.
- G. Cleanouts in unfinished concrete floors shall be Smith No. 4243S DUCO cast iron cleanout with round adjustable cast iron top with non tilt tractor cover, tapered thread bronze countersunk plug and vandal proof top, center securing screw.
- H. Cleanouts installed outside building shall be Smith No. 4253S DUCO cast iron cleanout and double flanged housing with heavy duty secured cast iron cover with lifting device, countersunk tapered thread bronze plug and vandal proof top. Housing shall be completely free of piping so that no loading is transmitted to the pipe. Cleanout to be set in 24" x 24" x 12" thick concrete slab flush with grade on pavement. Concrete slab by Plumbing Contractor.

2.4 TRAPS

- A. Exposed Fixture Traps shall be chrome-plated brass.
- B. Concealed Fixture Traps
 - 1. 2 Inches and Under: Extra heavy weight brass, recessed drainage type with brass cleanout plug in bottom.
 - 2. 3 Inches and Larger: Cast iron with clean out in the trap inlet or brass plug in bottom or side.

2.5 TRAP PRIMERS (TP)

- A. Manufacturers:
 - 1. Mifab
 - 2. Precision Plumbing Products
 - 3. Smith
 - 4. Watts
 - 5. Zurn
- B. Single Trap Primer: ½" cast bronze, automatic trap primer, non-liming actuator.
- C. Multiple unit trap primer: Diaphragm operated trap primer, capable of supplying eight (8) drain traps, operating range 35 to 75 psig.
- D. Trap primers shall comply with ANSI/ASSE standard 1018.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install trap seal primer valves in accessible ceilings or behind access panel with outlet piping pitched down toward drain trap a minimum of 1 percent and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- B. 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. Use NPS 4 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.
 - 4. Locate at base of each vertical soil and waste stack.
 - 5. Install wall mounted cleanouts 18" above finished floor.
- C. Install cleanout deck plates with top flush with finished floor, for floor cleanouts for piping below floors.
- D. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.
- E. Install flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.
- F. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to manufacturer's written instructions.
- G. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1" clearance between vent pipe and roof substrate.
- H. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
 - 1. Install roof-drain flashing collar or flange so no leakage occurs between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 - 2. Position roof drains for easy access and maintenance.
- I. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.
- J. Fasten recessed-type plumbing specialties to reinforcement built into walls.
- K. Install wood-blocking reinforcement for wall-mounting and recessed-type plumbing specialties.
- L. Install individual shutoff valve in each water supply to plumbing specialties. Install shutoff valves in accessible locations.
- M. Install air vents at piping high points. Include ball valve in inlet and drain piping from outlet to floor drain.
- N. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

- O. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Ground equipment.
- D. 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.
- E. Connect plumbing specialties and devices that require power according to Divisions 26 and 28 Sections.

3.3 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221430

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SECTION 224000 – PLUMBING FIXTURES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The General Conditions, Special Conditions and Division 1 through Division 32 as set forth in these specifications are hereby incorporated into and shall become a part of the specifications for work under this title, insofar as they apply hereto.
- B. Provide plumbing piping specialties or accessories as required by either the Equipment Manufacturer or the Local Code Authority.
- C. Provide plumbing fixtures as indicated on the Drawing and Schedules.
- D. Provide trim, fittings, carriers, stops and all accessories required for a complete installation.

1.2 DEFINITIONS

- A. ADA Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Fitting: Device that controls flow of water into or out of plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.
- C. Tepid: Approximately 85°F temperature with an allowable variation of +/- 5°F.

1.3 SUBMITTALS

- A. Submit per the provisions of Section 220500.
- B. Product Data: Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports and indicate materials and finishes, dimensions, construction details, and flow-control rates for each type of fixture indicated.
- C. Shop Drawings: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.
- D. Maintenance Data: For plumbing fixtures to include in maintenance manuals specified in Section 220500.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one (1) source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- 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. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- D. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Hand Sinks: NSF 2 construction.

2. Stainless-Steel Fixtures Other Than Service Sinks: ASME A112.19.3M.
 3. Vitreous-China Fixtures: ASME A112.19.2M.
 4. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
- E. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
1. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
 2. Faucets: ASME A112.18.1M.
 3. Hose-Connection Vacuum Breakers: ASSE 1011.
 4. Hose-Coupling Threads: ASME B1.20.7.
 5. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 6. NSF Materials: NSF 61.
 7. Pipe Threads: ASME B1.20.1.
 8. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
 9. Supply and Drain Fittings: ASME A112.18.1M.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES AND ACCESSORIES

A. PLUMBING CONTRACTOR FURNISHED FIXTURES

See schedules on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water soil and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer's roughing-in data if roughing-in data are not indicated.
- B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FIXTURE INSTALLATION

- A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. For wall-hanging fixtures, install off-floor supports affixed to building substrate.
 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

- C. Install back-outlet, wall-hanging fixtures onto waste fitting seals and attach to supports.
- D. Install wall-hanging fixtures with tubular waste piping attached to supports.
- E. Install counter-mounting fixtures in and attached to casework.
- F. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.
- G. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 - 1. Exceptions: Omit shutoff valve to emergency equipment.
- H. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- I. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- J. Install flush meter valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- K. Install toilet seats on water closets.
- L. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- M. Install water-supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.
- N. Install shower, flow-control fittings with specified maximum flow rates in shower arms.
- O. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- P. Install chrome plated brass escutcheons at piping wall or ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings.
- Q. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Refer to Division 7 Section "Joint Sealants" for sealant and installation requirements.

3.3 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings and specialties.
- B. Connect water supplies from water distribution piping to fixtures.
- C. Connect drain piping from fixtures to drainage piping.
- D. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.
- E. Ground equipment.

1. 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. Verify that installed fixtures are categories and types specified for locations where installed.
- B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.5 MOUNTING HEIGHTS

- A. Fixtures to be mounted at the following heights or according to manufacturer's recommendations, unless noted or directed otherwise.
 1. Regular Mounting Heights
See Architectural drawings and sections for fixture mounting heights.
 2. Handicapped Mounting Heights
See Architectural drawings and sections for fixture mounting heights.

3.6 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Adjust water pressure at faucets, shower valves, and flushometer valves to produce proper flow and stream.
- C. Replace washers and seals of leaking and dripping faucets and stops.
- D. Adjust equipment temperature settings.

3.7 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 2. Remove sediment and debris from drains.

3.8 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224000

SECTION 230000 – HEATING, VENTILATING, AND AIR CONDITIONING WORK

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. This Section includes a summary of all Heating, Ventilating, and Air Conditioning related work.

- B. Related Sections:

1. 230000 – Heating, Ventilating, and Air Conditioning Work
2. 230400 – General Heating, Ventilating, and Air Conditioning (HVAC) Requirements
3. 230500 – Common Work Results for HVAC
4. 230513 – Common Motor Requirements for HVAC Systems
5. 230515 – General Piping Requirements
6. 230517 – Sleeves and Sleeve Seals for HVAC Piping
7. 230518 – Escutcheons for HVAC Piping
8. 230519 – Meters and Gages for HVAC Piping
9. 230523 – General Duty Valves for HVAC Piping
10. 230529 – Hangers and Supports for HVAC Equipment
11. 230548 – Vibration Controls for HVAC Piping and Equipment
12. 230553 – Identification for HVAC Piping and Equipment
13. 230593 – Testing Adjusting and Balancing for HVAC
14. 230700 – Pipe Insulation
15. 230702 – Duct Insulation
16. 230800 – Commissioning of HVAC
17. 231123 – Natural Gas Piping
18. 232111 – Piping Materials
19. 232113 – Hydronic Piping
20. 232116 – Dual Temperature Water System
21. 233113 – Metal Ducts
22. 233300 – Air Duct Accessories
23. 233713 – Diffusers, Registers, and Grilles
24. 237414 – Energy Recovery Ventilators
25. 238219 – Fan Coil Units

1.3 DESCRIPTION

- A. The General Conditions, Special Conditions and Division 1 through Division 32, as set forth in these specifications, are hereby incorporated into and shall become a part of the specifications for work under this title, insofar as they apply hereto.
- B. Furnish material, labor, tools, accessories and equipment to complete and leave ready for operation all HVAC systems for this project as described in these specifications and as shown on the drawings, or as required.

1.4 SCOPE OF WORK

A. Work includes, but is not limited to:

1. Install dual temperature water piping as indicated.
2. Furnish and install fan coil units.
3. Make all connections from existing piping to new fan coil units.
4. Furnish and install air to air energy recovery ventilator.
5. Furnish and install all required condensate, equipment and drain piping.
6. Furnish and install pipe, equipment and duct insulation.
7. Furnish and install new instruments as shown.
8. Furnish and install new ductwork and all associated grilles, diffusers, registers, etc.
9. Furnish and install air and water balancing.
10. Perform final setting and leveling of all new equipment.
11. Perform start-up for all HVAC systems and commission same in accordance with the commissioning requirement.
12. Provide and/or participate in training of Owner's personnel on the use of all new HVAC systems.
13. Refer to drawings for Schedules of HVAC Equipment.
14. The contractor shall exercise adequate protective and safety measures for all persons and property and shall be responsible for any damages or injuries arising from the execution of this work.
15. Alterations and additions to existing work shall include the requisite dismantling of the old equipment, rigging, wrecking, hauling, protections of permanent equipment and the building structures, and cleaning up. Care shall be exercised to keep dust and dirt to a minimum and to confine it to the area where the removal work is being performed. All debris shall be promptly removed.
16. If asbestos insulation is encountered on any existing piping which is to be removed or remodeled, contractor shall immediately notify Owner of the existence of asbestos and Owner will arrange proper removal of same without cost to contractor.
17. Unless otherwise noted, remove all other existing equipment and piping, valves, fittings, etc. which will not be reused in the final arrangement. Unless otherwise noted, all items which will be removed by this this contractor and not reused shall become the property of the contractor and shall be promptly removed from the site by him.
18. All work necessitating the temporary turning off or shutting down the operation of existing mechanical and/or electrical facilities shall be done at times specifically approved by the Owner and Engineer in advance of any disruption of existing facilities. Also, refer to Section 23 04 00 – General Heating, Ventilating, and Air Conditioning (HVAC) Requirements.

B. Demolition Work

1. Coordinate all Demolition with the Owner so that shutdowns occur at times agreeable to the Owner.

2. The HVAC Contractor shall remove certain existing air handling and water systems. The existing plans are available for review at the Engineer's Office and the Owner will provide access to contractors desiring to verify existing conditions. The contractor shall be responsible to verify the extent of demolition work and shall include in their bid all demolition work affecting their trade.

1.5 EXCAVATION AND BACKFILLING AND RESTORATION OF SURFACES

- A. This paragraph is not applicable to this project.

1.6 EQUIPMENT

- A. Any and all costs associated with piping, electric, wiring, conduit, supports, pads, or other modifications to accommodate installation for manufacturer's equipment that differs from equipment layout on drawings shall be included on contractor's bid. The contractor is responsible to insure that the equipment will fit within space allocated with appropriate clearances for maintenance, operation, servicing, and code.

1.7 DUKE ENERGY INCENTIVE PROGRAM

- A. Comply with all requirements of the Duke Energy Incentive Program in order that the Owner will be able to obtain incentive monies from Duke Energy for this project. If Duke Energy requirements are more restrictive than the specifications, the Duke Energy requirements shall govern. A copy of the Duke Energy Incentive information for equipment is available on their web site. The contractor shall complete these forms, provide all requisite documentation, and present this information to the Owner for submission to Duke Energy. The incentive monies shall be solely available to the Owner.

1.8 QUALIFICATIONS

- A. Installer: Company specializing in performing the work of this Section with minimum three years documented experience.

1.9 LICENSES

- A. The installation of this HVAC work shall be made by Contractors and craftsmen licensed by the Governing Authorities.
- B. Obtain all permits and licenses required by code authorities having jurisdiction.

1.10 FEES

- A. The Owner will obtain and pay for the building permit. The Contractor shall obtain all inspections or additional permits required by all laws, ordinances, rules, regulations or public authority having jurisdiction and obtain certificates of such inspections and permits and submit same to the Architect. The Contractor shall pay all fees, charges and other expenses in connection therein for HVAC work including inspection fees, etc. associated with the building permit.

1.11 CODES, REGULATIONS AND STANDARDS

- A. Unless otherwise noted, the following latest enforced Edition shall apply to this work:

Ohio Building Code

Life Safety Code

National Fire Protection Association

Ohio Fire Code

OSHA Requirements

EPA Requirements

1.12 QUALITY ASSURANCE

- A. The HVAC Contractor shall be responsible for all costs associated with changes to wire size, conduit size, fuse size, starter size, pipe size, duct size, monitoring, supports, etc. caused by the change of equipment from the basis of design specified to other named manufacturers. The Contractor is responsible to insure that the other manufacturer named supplied equipment will fit within space allocated, with appropriate clearances for maintenance, operation, service, code requirements, etc. Any contractor utilizing a manufacturer other than basis of design shall be responsible for any additional requirements for electrical service, concrete pad size, physical space limitations, and capacities at no additional cost to the building Owner. If manufacturers are listed, no other manufactures except those listed within the Sections of this Division, that are able to comply with the contract document requirements and minimum standards of these specifications, will be acceptable.
- B. Work provided or performed by the Contractor shall be guaranteed to be replaced and made good at his own expense any defects which may develop, within one (1) year after final payment and acceptance by the building Owner, due to faulty workmanship or material, upon receipt of written notification of the defect from the building Owner.

1.13 COORDINATION DRAWINGS

- A. General:
 - 1. The HVAC Contractor shall be in charge of the coordination drawing process and shall be responsible to resolve all conflicts and settle any disputes resulting from the coordination drawing process.
 - 2. Contract drawings are diagrammatic. Included in the base bid shall be all offsets, fittings, etc. for a completed project.
 - 3. Field discrepancies shall be resolved by the field foreman. When discrepancies cannot be resolved, the signed-off coordination drawings shall be re-examined for rights.
 - 4. Documented, coordinated, dimensioned work will have precedence. Owner will not pay for rework of a particular trade. Uncoordinated work will not be tolerated.
 - 5. Coordination drawings shall be a phased process with the General Contractor, HVAC Contractor, Architect and Engineer determining the sequence of work.
 - 6. Each Contractor shall coordinate the exact location of their work with the work of other trades prior to fabrication or installation of same. Verify all dimensions and elevations. Provide additional offsets and sections of material as may be required to meet the applicable job condition requirements. Coordinate with and review all related Construction Drawings and Shop Drawings of all equipment suppliers prior to start of work.
 - 7. It is the responsibility of the HVAC Contractor to coordinate between his equipment suppliers and his temperature control subcontractor and other subcontractors as to which control devices are supplied with equipment, required wiring and voltages, and other related coordination times, so as to ensure a complete, proper, and operable installation.

B. Process

1. The HVAC Contractor shall have precedence for the allotment of available space. Ductwork rerouting for gravity drain lines may be required and shall be approved by the Engineer.
2. The HVAC Contractor shall be responsible for all trades, pre-coordinating their layouts and shop drawings with each other, including the HVAC Contractor.
3. The Sheet Metal Contractor shall prepare a BIM model (Revit or Navisworks). He shall be responsible for the base drawings to be used by all other Contractors. Base drawings shall include architectural, structural and reflected ceiling plan information.
4. The Sheet Metal Contractor shall prepare ductwork drawings, at a minimum scale of 1/4" = 1'-0", in a BIM model (Revit or Navisworks). After he has finished, a CD with base drawing and ductwork shall be circulated in the following order:
 - a. Plumbing Contractor
 - b. Piping Contractor
 - c. Electrical Contractor
 - d. General Contractor
5. Each Contractor shall use the CD for preparation of their installation drawings.
6. After all trades have completed the coordination process, the General Contractor shall hold a coordination meeting to resolve conflicts. Each Contractor shall have available a drawing of his layout to be used with a light table for overlaying purposes. A representative of each Contractor, the Architect and the Engineer shall attend. All conflicts shall be resolved at the coordination meeting. The Architect and Engineer shall resolve all major conflicts as to the degree each Contractor shall alter their layout in order to allow for sufficient space for installation of the work.
7. After all work is coordinated and all conflicts resolved, each contractor shall update coordination documents in order to reflect all required minor and major modifications.
8. When all coordination is complete, the HVAC Contractor shall distribute two (2) sets of prints of the revised coordination drawings to each of the trades involved in the project, one (1) set for the Owner's Representative and one (1) set for as-built drawings.

C. HVAC Contractor:

1. All horizontal ducts shall be located and dimensioned from column center lines. Each duct shall be drawn to scale with width, depth and bottom of duct elevation clearly noted.
2. All vertical ducts shall be located from column center lines in two (2) directions. When concealed in a shaft, each vertical duct shall be shown in its total length.
3. Terminal units, heating coils, fire dampers, grilles and diffusers shall be located and dimensioned. Terminal units shall be located so as to be readily accessible from removable ceiling panel or access panel. All necessary clearances, required by codes, shall be maintained.

- D. Electrical Contractor:
 - 1. Conduits less than 1" in size are not required to be indicated on coordination drawings; however, the Electrical Contractor is responsible for routing these conduits in a manner to not cause a conflict with other trades. Conduits not indicated on coordination drawings shall be field offset to avoid all conflicts.
- F. General Contractor:
 - 1. All furrings and holes shall be clearly noted.
 - 2. All ceiling heights shall be clearly noted.
- G. Service Areas:
 - 1. Contractors shall indicate service areas for all equipment, terminal units, etc. by shaded areas on drawings.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 EXISTING WORK

- A. Each Contractor shall locate existing site utilities, installed in previous phase, prior to beginning work. Provide adequate means of protection during work operations. Repair existing utilities damaged during work operations to the satisfaction of the utility owner and at Contractor's expense.
- B. Should uncharted or incorrectly charted piping or other utilities be encountered during work operations, notify the Engineer immediately for procedure directions. Cooperate with utility companies in maintaining active services and facilities in operation.

3.2 OPENING LOCATIONS AND CUTTING

- A. Each Contractor shall give the General Contractor locations and sizes of all openings required for the installation of new mechanical work before new walls, etc. are started.
- B. All cutting through poured concrete slabs and walls shall be done with core drills. No jack hammers will be allowed. All cutting and patching by General Contractor that is coordinated by the HVAC Contractor. All cutting and patching not coordinated by the HVAC Contractor with the General Contractor shall be by the HVAC Contractor.

3.3 CLEANING AND PAINTING

- A. All equipment shall be kept dry and clean during the construction period.
- B. Prime and paint by General Contractor, unless otherwise noted.
- C. When all work is completed and all work has been satisfactorily tested and accepted by the Architect, mechanical equipment and other exposed surfaces shall be thoroughly cleaned.
- D. Repair marred and damaged factory painted finish with materials and procedures to match original factory finish.

3.4 EXCAVATION AND BACKFILL

- A. This paragraph is not applicable to this project.

3.5 CONCRETE WORK

- A. Each Contractor shall provide concrete pads required for equipment they have supplied. See Division 3 - Cast-in-Place Concrete.

3.6 PROTECTION AND DAMAGE

- A. In addition to the provisions and stipulation of the General Conditions, each contractor and subcontractor shall provide various types of protection as follows:
 - 1. Protect finished floors from chips and cutting oil by the use of metal drip receiving pan and oil proof floor cover.
 - 2. Protect equipment and finished surfaces from welding and cutting splatters with baffles and splatter blankets.
 - 3. Protect equipment and finished surfaces from paint droppings, insulation adhesive and sizing droppings, etc. by use of drop cloths.
- B. All equipment shall be stored at the site with openings, bearings, etc., covered to exclude dust and moisture. All stock piled pipe shall be placed on dunnage and protected from weather and from entry of foreign material.
- C. Piping and construction openings and excavations required for Mechanical work shall be covered when work is not in progress as follows:
 - 1. Cap pipe openings with fittings or plugs.
 - 2. Cover wall and ceiling openings with plywood, or canvas covered framing.
 - 3. Cover floor openings and excavations with structural material of adequate strength to support traffic.
- D. The Owner's property and the property of other Contractors shall be scrupulously respected at all times (including damage from leaks). Provide drop cloths and visqueen or similar barriers where dust and debris is generated, to protect adjacent area.
- E. Contractor shall be held responsible for damage caused by his work or through neglect of his workmen. Repairing of damaged work shall be done by Contractor as directed by the Architect. Cost of repairs shall be paid by Contractor.
- F. The Owner reserves the right to make emergency repairs as required to keep equipment in operation without voiding the Contractor's guarantee bond not relieving the contractor of his responsibilities during the bonding period.

3.7 SPECIAL ATTENTION

- A. In order to save time, and make selections of equipment based upon life cycle costs, the boilers, chillers, cooling towers and AHU's will be purchased under a separate contract.
- B. Temperature controls will be performed under a separate contract.
- C. After all dust making procedures are performed and finishes cured, HVAC Contractor shall start all air handling units in order to purge the building. HVAC Contractor shall adequately protect each intake of air handling units with disposable filter media to prevent damage to units. HVAC Contractor shall perform service maintenance; thoroughly clean all units including coils, and replace filters on all air handling units before the Owner occupies the space and at no additional cost to the Owner.

END OF SECTION 230000

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SECTION 230400 - GENERAL HEATING, VENTILATING, AND AIR CONDITIONING (HVAC) REQUIREMENTS

PART 1 - GENERAL

1.1 HVAC WORK

- A. The following paragraphs are applicable to Division 23 and are complementary to other sections of specifications. Where items described in other sections of the specifications are repeated herein, it is done to call special attention to or to qualify them, but it is not intended that any part of the documents shall be assumed to be omitted if not repeated herein.
- B. Where contradictions occur between this section and Division 1, the more stringent of the two shall apply. Architect/Engineer shall decide which is most stringent.

1.2 DRAWINGS AND SPECIFICATIONS

- A. HVAC drawings are diagrammatic and indicate general arrangement of systems and work included in the contract and shall be adhered to insofar as possible. The drawings and specifications are complementary and are intended, without giving every minute detail, to cover a workable installation complete in every respect including, whether mentioned or not, all material and equipment usually furnished with such systems and/or needed to make a complete operational installation omitting only such parts as are specifically excepted.
- B. Consult drawings and details for exact location of fixtures and equipment, and where not definitely indicated, request this information in writing.
- C. The specification for each division of the work is written in sectional form for brevity and convenience in reference, without repeating in each section all applicable general clauses and/or pertinent data covered elsewhere in the specification, but it is not intended that any of the documents shall be assumed to be omitted if not repeated in each division.
- D. Where specifications are written for brevity, with incomplete sentences, the omission of words or phrases, such as "the contractor shall", "shall be", "provide", "furnish", "all", etc. are intentional and such omitted words or phrases shall be supplied by inference; unless otherwise mentioned, such clauses, lists, and/or directives indicate work to be done by the contractor for that specific division of work.

1.3 VERIFYING CONDITIONS

- A. The work under this contract occurs on the site of and within the existing facility. The work under this contract shall be scheduled and performed so as to provide a minimum of interference with the normal operation of the existing facilities.
- B. Before submitting a proposal, contractors shall visit the site, and shall also carefully examine all bidding documents including those for other branches of the work, to satisfy themselves as to the nature and scope of all work to be done. Prints showing the original building architectural, structural, mechanical, and electrical work are available at the Engineer's office for contractors' review.
- C. The submission of a proposal shall be taken as evidence that such an examination has been made and difficulties, if any, noted. Later claims for labor, work, material, and equipment required for any difficulties encountered which could have been foreseen, shall not be recognized, and all such difficulties shall be properly taken care of by the contractor at no additional expense to the Owner.

1.4 EXISTING WORK AND/OR CONDITIONS

- A. The accompanying drawings and specifications illustrate and describe the existing conditions, mechanical utilities, sewers, water mains, pipes, ducts, conduits, etc. that are particularly relevant to the new work insofar as these mains are shown on existing records or evident by field inspections and tests; however, it is not the intent that these documents shall be construed to guarantee to the contractor the exact location of these items. Each contractor shall verify and determine the exact location of these items in the field, and all work under this contract shall be executed to avoid conflict with or damage to existing work. The work shall be planned and executed to avoid interference, as much as possible, with traffic and with the normal use of the existing facility.
- B. All work involving hazards to persons shall be suitably barricaded and provided with warning lights or signs, as required.
- C. Where necessary for the performance of the contract, existing work shall be cut, altered, removed, or temporarily removed and replaced. Work that is altered or replaced shall match similar existing work and said work shall be performed by trade applicable to the work; if said work is NOT shown or noted the Drawings relating to applicable trade, cost shall be paid by contractor requiring said work. However, unless otherwise provided by the drawings or specifications, no structural members shall be cut or altered without authorization of the Architect and Engineer. Work remaining in place, which is damaged or defaced by reason of work done under this contract, shall be restored in kind equal to its condition at the time of award of the contract by applicable trade as hereinbefore specified.
- D. Existing work shall not be disturbed further than necessary for proper installation of new work. New work to be connected or made integral with existing work shall be properly erected to secure solidity and be continuous in finish. Such new work in extension of existing work shall correspond in all respects with that to which it connects, or similar existing sound work, unless otherwise specified.

1.4 EXISTING MECHANICAL FACILITIES

- A. Where existing mechanical facilities and/or service lines occur in the area of the work and such facilities or lines are to be abandoned or changed, the contractor for the branch of work or trade involved shall cut off and properly cap the old lines, so as not to interfere with the new construction work. If any portions of such lines are required for the operation of an existing building the lines shall be altered and relocated to clear new construction and shall also be restored into service to provide continued operation of the existing building.

1.5 INTERRUPTION OF SERVICES

- A. Work which requires the temporary turning off or shutting down the operation of existing mechanical and/or electrical facilities shall be done at times specifically approved by the Owner or utility company and the work shall be pre-scheduled and executed so there is a minimum outage of such services and/or delay in the new construction work.
- B. Unscheduled interruptions of the facility will not be tolerated. The contractor shall exercise extreme caution, shall thoroughly inform his workmen and subcontractors of the critical nature of this work, and shall continually review the work procedure being followed in order to prevent accidental interruption of service. Before performing any act which could result in interruption of service, the contractor shall notify the Owner and Engineer of the hazards involved and the contractor shall proceed in a manner and at a time specifically approved by the Owner and Engineer.
- C. All work necessitating the temporary turning off or shutting down the operation of existing mechanical and/or electrical facilities shall be done at times specifically approved by the Owner and Engineer in advance of any disruption of existing facilities.

1.6 MATERIALS AND EQUIPMENT

- A. All materials and equipment entering into the work shall be approved by the Engineer, and must be new, without defects, and of the sizes and capacities shown on the drawings or hereinafter specified. All manufactured materials or equipment shall bear the identification mark of the manufacturer or, if required by the Engineer, shall be certified by an approved testing laboratory. All equipment shall operate within the manufacturer's range of speeds, guaranteed capacities, performance, etc. as indicated by the manufacturer's latest catalog and/or engineering data, shall be of proper size and dimension for the allocated space, and shall be placed in the space allocated in the proper construction sequence. Special consideration will be given to equipment which has been in successful field use or similar applications for at least three (3) years (exclusive of field tests), and to equipment which has an extended guarantee period in lieu of long use period. The contractor shall submit with his bid complete data on equipment he proposes to use; failure to so submit, or to meet these requirements fully and those of the specifications, shall be grounds for rejecting the items.
- B. All electrical materials, apparatus, and equipment shall be new, of the make and characteristics specified, shall conform to NEMA standards, and shall be designed to comply with and be installed in accordance with the latest rules and regulations of the National Electrical Code, and all of the legally constituted public authorities having local jurisdiction. Verify the exact voltage and current characteristics at the building before ordering motors or similar equipment.
- C. All motors shall be NEMA frame sizes, heavy duty, 40 degree C. ambient motors with ball or roller bearings and with maximum full load temperature rise not exceeding NEMA limits of temperature rise. All motors shall have adequate starting and protective equipment as specified or required, and shall have a conduit terminal box of size adequate to accommodate conduits and wires as sized on electrical drawings or as specified. The capacity of each motor shall be sufficient to operate associated driven devices under all conditions of operation and load without overloading or overheating and each motor shall be of not less than the horsepower indicated or specified.
- D. Conduct such tests and adjustment of equipment as specified or necessary to verify performance requirements. Submit data taken during such tests.

1.7 QUIET OPERATION

- A. The work shall be installed in such a manner that under all conditions of load it shall operate without sound or vibration which is objectionable in the occupied spaces, in the opinion of the Engineer.
- B. In case of moving machinery, sound or vibration noticeable outside of the room in which it is installed or annoyingly noticeable inside its own room will be considered objectionable. Sound or vibration considered objectionable shall be corrected by the contractor.

1.8 PROTECTION

- A. In performing this contract, safeguard workmen and the public and protect the work and equipment until final completion and acceptance. After delivery and before and after installation, protect work against theft, injury, or damage. Carefully store material and equipment received on site which are not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of obstructing materials. Protect related or adjacent work and the material of the other trades or the Owner from damage that might be caused by this work and make good any damage thus caused. Provide all safeguards, scaffolding, drop cloths, etc. as required.
- B. No welding or soldering shall be done near combustible materials of any kind; all adjoining work, finished surfaces, glass, etc. shall be protected from flames, sparks, hot metal, etc. by metal guards or approved noncombustible drop cloths or barriers.

- C. Each contractor shall replace any items or portions thereof wherever removed or damaged, in a manner equal to the original construction and finish, or where directed by the Engineer, he shall pay other trades to perform this work.
- D. All mechanical equipment with a factory finish shall be protected during construction and must be free of dust, dirt, cement splatters, etc. when the building is turned over to the Owner. Dents and marred finishes shall be repaired to the satisfaction of the Engineer, or a replacement furnished where necessary.
- E. Provide belt drives and rotating machinery with readily removable guards complying with OSHA requirements to enclose the drive completely and consisting of heavy angle iron frames, hinged and latched, with heavy galvanized iron wire crimped mesh or sheet steel securely fastened to frames.

1.9 EXECUTION OF WORK

- A. The HVAC Work shall be performed and coordinated with the program of the General Contractor and the other subcontractors. Promptly upon award of the contracts, the subcontractors shall confer with the General Contractor and the Engineer and other subcontractors to prepare a time schedule for the completion of the various divisions and details of the work. Each subcontractor shall proceed diligently with the work and shall cooperate with the General Contractor and the other contractors to maintain the approved time schedule to the best of his ability and as conditions permit.

1.10 GENERAL SUPERVISION AND INSTALLATION OF WORK

- A. Each contractor shall at all times give the work his best skill and attention, including adequate construction supervision over his work, employees, and subcontractors, and he shall fully cooperate with and confer with the Engineer and other contractors so that the best possible installation shall be obtained. Exact locations and relations are to be determined in the field, subject to the approval of the Engineer, and with preference to the dimensioned and architectural and structural drawings and approved shop and setting drawings.
- B. Unless otherwise shown, pipes, ducts, etc. in rooms with finished ceilings, shall be concealed in furred ceilings, shafts, walls, and floors, and all work must be exactly and accurately located to conform with the spaces provided therefor. In general, all other new piping, ducts, etc. in mechanical equipment rooms, telephone rooms, etc. shall be exposed.
- C. Install pipes, ducts, etc. in a neat and workmanlike manner, close to walls, generally as high as possible, true and square to the building, utilizing standard practices, and properly graded for correct functioning of the system involved; multiple lines in close proximity shall be coordinated and neatly grouped. Install work in proper construction sequence and arranged so as to be readily accessible for operation, maintenance, and repair; minor deviations from drawings may be made to accomplish this, but changes of magnitude or which involve extra cost shall not be made without approval. All fixtures, outlets, etc. shall truly center with the adjacent architectural finish. All work, both exposed and concealed, shall meet the approval of the Engineer regarding neatness of appearance, location, and practicability of installation. The Engineer reserves the right to direct the removal and replacement of any item which, in his opinion, does not present an orderly and reasonably neat and workmanlike appearance.
- D. Each contractor shall familiarize himself with the work of the other contractors, shall perform and coordinate his work with the other contractors, shall lay out his work to meet conditions at the building, shall give freedom to and prevent conflict with the work of other contractors, and shall make reasonable modification in locations or arrangement from those indicated on the drawings if required to avoid conflicts or to conform to tile, wood, marble, or other architectural finish. From time to time as the work progresses, the contractor shall examine the work installed by others, insofar as it may

affect his work, and he shall, before proceeding with the work, notify the Engineer in writing, if any condition exists which prevents the successful installation of his own work.

- E. If the contractor places any work in violation of any of the above mentioned requirements, and conflicting or unworkmanlike conditions result, he shall, without additional charge, remove and reinstall or satisfactorily readjust such portions of his work as may be necessary and as the Engineer may direct. The Engineer's decision regarding such conditions shall be final.

1.11 ENGINEER'S OBSERVATION

- A. A periodic inspection of the work by the Engineer, commonly referred to as supervision, is only for the express purpose of verifying compliance by the contractor with the contract documents. Such engineering inspections and services rendered by the Engineer or his representatives shall not be construed as the supervising of construction; nor the assuming by the Engineer of the duties and responsibility of the contractors nor making the Engineer responsible for providing a safe place or procedure for the performance of the work or for the contractor's employees or for subcontractors.

1.12 EXCAVATION AND BACKFILLING OF TRENCHES, ETC.

- A. This paragraph is not applicable to this project.

1.13 RESTORATION OF SURFACES AND CONCRETE WORK

- A. Unless otherwise specified, all new concrete work for parking lots, driveways, pads, etc. shall be provided by the general contractor. Unless otherwise specified, all new concrete work for pads, and all surfaces such as concrete floors, walls, paving, sidewalks, roof deck, or other surfaces disturbed in the execution of work, and which remain in use, shall be restored in kind by this contractor, or he shall pay the cost of such work.
- B. Where this contractor has performed excavation work, this contractor shall backfill as hereinbefore specified in Paragraph 1.16.
- C. In Landscaped Areas, such as grass or plantings, the final 6" of backfilling, grading, seeding, mulching, and planting shall be performed by a qualified, competent Landscaping Contractor. The Mechanical Contractor shall include in his bid the cost of such landscaping services and shall warrant same as described under Paragraph 24.
 - 1. This final 6" of backfill provided by the approved Landscaping Contractor shall consist of top soil complying with Ohio DOT 653.02; ph 6.0 to 7.0 or adjusted within these limits, raked to a uniform fineness and free of rock or stones 1" or greater in any dimension.
 - 2. Where grass has been disturbed, the Landscape Contractor shall apply 8/32/16 organic fertilizer at rate of 1 lb. per 5 square yards and seed with 90-95% pure, 85% (minimum) germination seed of a mixture of 20% Rye grass, 40% creeping red fescue, and 40% Kentucky blue grass at a rate of 7 lbs. per 1000 square feet. Cover seeded areas with clean, weed free straw.
 - 3. If shrubbery and plantings must be disturbed, the Landscaping Contractor shall either remove, maintain, and reinstall said plantings or the Landscape Contractor shall furnish healthy new shrubbery and plantings similar in kind to that which was removed. In either case, the Landscape Contractor shall fertilize and provide mulch around said plants.

- D. Concrete Work, shall be performed by a qualified, competent, Concrete Contractor, and work shall comply with the following:
1. Sidewalks shall be concrete, Class C, unreinforced, complying with ODOT 608. Width and finish shall match existing adjacent sidewalks. Sidewalks shall be the same depth as the existing adjacent sidewalks or 7" deep whichever is greater.
 2. All other concrete for parking lots, driveways, and pads shall be 4000 PSI compressive strength concrete with reinforcing steel. Thickness of concrete for parking lots and driveways shall be not less than 7" thick. Reinforcing steel shall be 6" x 6" 58 pound welded wire fabric (WWF) top and bottom. All welded wire fabric shall be in flat sheets, not rolls.

1.14 SLEEVES, CUTTING, PATCHING, CLEANING, WATERPROOFING, ETC.

- A. Provide and accurately set frames and Schedule 40 steel pipe sleeves for required openings in new work to minimize cutting. Perform all cutting, patching, etc. required to install the work. Use approved power operated boring machine for small holes wherever practical. Remove all rubbish incidental to the work. Where any work pierces waterproofing, provide all necessary sleeves, caulking, and flashing required to make openings absolutely watertight.
- B. Refer to the ACI Code 381.71, Section 6.3 for limitations and requirements for penetrations and openings.

1.15 PATENTS

- A. The contractor shall defend and guarantee the Owner against any expense, claims, litigation, etc. occasioned by the use in this work of any materials, devices, etc. covered by patents not owned by the contractor, or of which he is not a licensed user.

1.16 CONTEMPLATED WORK

- A. The work contemplated occurs on the site of and within the existing building.
- B. The drawings and specifications for the mechanical and electrical portion of this project have been prepared by Motz Consulting Engineers, Inc., doing business as Motz Engineering.
- C. The various items of work necessary for completion of this work are hereinafter specified under the respective section headings or shown on accompanying drawings, and shall be included in any contract or contracts made for completion of respective divisions of the work. Such contracts shall also include necessary details reasonably incidental to the proper execution and completion of such work.

1.17 MOVING MATERIALS

- A. If it becomes necessary at any time during the progress of this work to move materials which have been temporarily located and which are to enter into the final construction, the contractor furnishing said materials shall, when so directed by the Engineer, move them or cause them to be moved. Cost of such moving shall be included in the contract price.

1.18 ACCIDENT PREVENTION

- A. Precaution shall be exercised at all times for the protection of persons and property. The safety provisions of applicable law, building, and construction codes shall be observed. Machinery, equipment, and other hazards shall be guarded in accordance with safety provisions of the "Manual of

Accident Prevention in Construction" published by Associated General Contractors of America to the extent that such provisions are not inconsistent with applicable law or regulations.

1.19 PROPERTY PROTECTION

- A. All hoisting shall be done with proper tag lines and buffers to prevent damage to the sides of the building. Where it is necessary to hoist materials to the roof, the parapets at top of the building and the roof where materials are landed from hoists shall be protected with heavy wood covers. Parapet protection shall be placed on both sides and top, and shall extend far enough on either side of landing point to insure adequate cover. The roof, from the landing point at parapet to final location of material, shall be adequately protected by planks laid side by side on roofing and spiked together on outside edges with planks running at right angles to main planking. The roof shall be adequately protected against leaks at all times.
- B. Where hoists are erected on the roof for hoisting material up the side of the building, the roof shall be adequately protected against abrasion or other damage. Materials stored on the roof shall be placed on planks or other protection approved by the Engineer and shall be placed only at locations approved by the Engineer.
- C. If hoisted materials are taken through windows, the jams, head, and sill shall be adequately protected with wood planking or proper buffers.
- D. Any work, equipment, or property damaged during construction of this project and due to operations under this contract shall be repaired or replaced by this contractor, without additional cost to the Owner. Upon completion of the work, the contractor shall remove all protections herein specified.

1.20 REMOVAL OF RUBBISH

- A. It shall be each contractor's duty to keep the building and surrounding premises clean, free from rubbish of every description. No rubbish, crating materials, packing, or dirt shall be allowed to accumulate at any time, but shall be removed at once and hauled away.
- B. Each trade shall be responsible for its own tools and materials during the periods of rubbish removal but contractors shall use reasonable care in removal of rubbish to protect the tools and materials of others against loss or damage. The Owner reserves the right, in the event that removal of rubbish is not promptly and properly carried out by the Contractors to have rubbish removed and to charge the cost of its removal to the contractor.
- C. Also, refer to Division 1.

1.21 MATERIAL SAFETY DATA SHEETS (MSDS)

- A. The contractor shall obtain and maintain on-site during the course of the project the Material Safety Data Sheets (MSDS's) for all chemicals or products containing chemicals that may be considered toxic or hazardous. The MSDS's are to be forwarded to the Office of Environmental Health and Safety upon completion of the project.

1.22 INSTRUCTION OF PERSONNEL

- A. The HVAC Subcontractor shall provide free on site instruction in the proper use of installed equipment to designated representatives of the Owner, sufficient to ensure safe, secure, efficient, non-failing utilization, and operation of systems. This instruction shall include the following:
 - 1. One Site Training: Provide a minimum of 24 hours of training for owner's staff. Submit a syllabus to the Engineer prior to the first session.

2. Support: Provide a minimum of 16 hours of support either on site or by telephone to answer operations questions.

PART 2 – (NOT USED)

PART 3 – (NOT USED)

END OF SECTION 230400

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SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following meters and gages for mechanical systems:
 - 1. Test plugs.

1.2 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated; include performance curves.
- B. Shop Drawings: Schedule for thermometers and gages indicating manufacturer's number, scale range, and location for each.

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 (1) of the manufacturers specified.

2.2 TEST PLUGS

- A. Manufacturers:
 - 1. Peterson Equipment Co., Inc.
 - 2. Sisco Manufacturing Co.
 - 3. Trerice, H. O. Co.
 - 4. Watts Industries, Inc.; Water Products Div.
- B. Description: 1/2 inch NPT, Corrosion-resistant brass body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.
- C. Minimum Pressure and Temperature Rating: 1000 psi at 350 deg F.
- D. Core Inserts: Two (2) self-sealing rubber valves.
 - 1. Insert material for air, water, oil, or gas service at 20 to 350 deg F shall be Nordel.

- E. Test Kit: Furnish one (1) test kit containing one (1) pressure gage and adaptor, two (2) thermometers, and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.
 - 1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3- inch diameter dial and probe. Dial range shall be 0 to 200 psig.
 - 2. Low Range Thermometer: Small bimetallic insertion type with 2 inch diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
 - 3. Carrying case shall have formed instrument padding.

PART 3 - EXECUTION

3.1 TEST PLUG APPLICATIONS

- A. Inlet and outlet of each heating and cooling coil.
- B. Inlet and outlet of each strainer on coils.
- C. Inlet and outlet of each temperature regulating valve.
- D. Inlet and outlet of each pressure reducing valve.
- E. Both inlets to differential pressure transmitters.

3.2 INSTALLATIONS

- A. Install test plugs in tees in piping. Install test plugs with sufficient clearance to permit installation of test gauges and thermometers.

3.3 CONNECTIONS

- A. Install test plugs adjacent to machines and equipment to allow service and maintenance for meters, gages, machines and equipment.

3.4 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 230519

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SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC 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. This Section includes basic requirements for factory-installed and field-installed motors.

1.3 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.

1.4 DEFINITIONS

- A. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.
- B. Field-Installed Motor: A motor installed at Project site and not factory installed as an integral component of motorized equipment.

1.5 SUBMITTALS

- A. Product Data for Field-Installed Motors: For each type and size of motor, provide nameplate data and ratings; shipping, installed, and operating weights; mounting arrangements; size, type, and location of winding terminations; conduit entry and ground lug locations; and information on coatings or finishes.
- B. Shop Drawings for Field-Installed Motors: Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:
 - 1. Each installed unit's type and details.
 - 2. Nameplate legends.
 - 3. Diagrams of power and control wiring. Provide schematic wiring diagram for each type of motor and for each control scheme.
- C. Qualification Data: For testing agency.
- D. Test Reports: Written reports specified in Parts 2 and 3.

- E. Operation and Maintenance Data: For field-installed motors to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.
- B. Source Limitations: Obtain field-installed motors of a single type through one source from a single manufacturer.
- 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 NFPA 70.

1.7 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices. Provide motors that are:
 - 1. Compatible with the following:
 - a. Magnetic controllers.
 - b. Multi-speed controllers.
 - 2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
 - 3. Matched to torque and horsepower requirements of the load.
 - 4. Matched to ratings and characteristics of supply circuit and required control sequence.
- B. Coordinate motor support with requirements for driven load; access for maintenance and motor replacement; installation of accessories, belts, belt guards; and adjustment of sliding rails for belt tensioning.

PART 2 - PRODUCTS

2.1 MOTOR REQUIREMENTS

- A. Motor requirements apply to factory-installed and field-installed motors except as follows:
 - 1. Different ratings, performance, or characteristics for a motor are specified in another Section.
 - 2. Manufacturer for a factory-installed motor requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.
- B. Comply with Energy Independence and Security Act of 2007.
- C. Comply with NEMA MG 1 table 12-11 unless otherwise noted.
- D. Comply with IEEE 847 for Severe-Duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Motor Phase: As indicated on drawings.
- B. Frequency Rating: 60 Hz.
- C. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.
- D. Service Factor: 1.15.
- E. Duty: Continuous duty at ambient temperature of 105 deg F and at an altitude of 3300 feet above sea level.
- F. 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.
- G. Enclosure: Open drip proof for interior mounted motors. Totally enclosed fan cooled for exterior mounted motors.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficiency.
- C. Stator: Copper windings, unless otherwise indicated.
 - 1. Multi-speed motors shall have separate winding for each speed.
- D. Rotor: Squirrel cage, unless otherwise indicated.
- E. Bearings: Double-shielded, pre-lubricated ball bearings suitable for radial and thrust loading.
- F. Temperature Rise: Match insulation rating, unless otherwise indicated.
- G. Insulation: Class F, unless otherwise indicated.
- H. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Designed with critical vibration frequencies outside operating range of controller output.
 - 2. Temperature Rise: Matched to rating for Class B insulation.
 - 3. Insulation: Class H.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
 - 5. Motor shall be design for vector or inverter-duty service with design resistant to transient spikes, high frequencies and short time rise pulse produced by inverters.
 - 6. Motor manufacture shall ensure specified motor operational and performance characteristics are suitable for inverter drive operation.
 - 7. Motor shall be provided with minimum of one shaft mounted grounding protection ring to discharge pulse width modulation induced shaft voltages and bearing currents in reducing the effects of bearing pitting and scoring.

8. Motor shall include factory wired internal automatic reset high temperature thermal protector switch wired to over sized motor terminal box.
- I. Rugged-Duty Motors: Totally enclosed, with 1.15 minimum service factor, greased bearings, integral condensate drains, and capped relief vents. Windings insulated with nonhygroscopic material.
 1. Finish: Chemical-resistant paint over corrosion-resistant primer.

2.4 SINGLE-PHASE MOTORS

- A. Type: One of the following, to suit starting torque and requirements of specific motor application:
 1. Permanent-split capacitor.
 2. Split-phase start, capacitor run.
 3. Capacitor start, capacitor run.
- B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.
- C. 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.
- D. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, pre-lubricated-sleeve type for other single-phase motors.
- E. Source Quality Control: Perform the following tests on each motor according to NEMA MG 1:
 1. Measure winding resistance.
 2. Read no-load current and speed at rated voltage and frequency.
 3. Measure locked rotor current at rated frequency.
 4. Perform high-potential test.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive field-installed motors for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Examine roughing-in of conduit systems to verify actual locations of conduit connections before motor installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 MOTOR INSTALLATION

- A. Anchor each motor assembly to base, adjustable rails, or other support, arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and align with load transfer link.
- B. Wiring of motor to controller and auxiliary controls and/or safeties shall be in accordance with motor controller manufacture instructions, NFPA 70 and local code requirements.
- C. Properly ground all equipment according to controller manufacturer's requirements regarding noise attenuation

and electromagnetic interference. Where not specifically specified by motor controller manufacture, ground equipment according to NFPA 70.

- D. Requirements of motor T-lead conductors shall comply with Division 26 Specification 260519 "Wires and Cable".

3.3 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:

1. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
2. Test interlocks and control features for proper operation.
3. Verify that current in each phase is within nameplate rating.

- B. Testing: Perform the following field quality-control testing:

1. Perform each electrical test and visual and mechanical inspection stated in NEMA ATS, Section 7.15.1. 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.

3.4 ADJUSTING

- A. Align motors, bases, shafts, pulleys and belts. Tension belts according to manufacturer's written instructions.

3.5 CLEANING

- A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean motors, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 230513

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SECTION 230515 - GENERAL PIPING REQUIREMENTS

PART 1 - GENERAL

1.1 PIPING SYSTEMS - GENERAL

- A. The following instructions apply to all piping systems, except where otherwise noted.
 - 1. Provide unions or flanges at each final connection and at each piece of equipment.
 - 2. Make connections to equipment as detailed on the Drawings or per manufacturer's installation instructions.
 - 3. Where connection size is smaller than piping, make reduction at final connection only (Do not reduce size of pipe drop).
 - 4. Provide valves and specialties as required, to complete installation of each piece of equipment, for proper operation.
- B. Clean out and flush water piping systems.
- C. If other means of draining are not provided, install drain valves at all low points to permit complete draining of each water system.
- D. Certified Pipe Welding Bureau. Welds to be stamped at each joint or fitting.
- E. Install dielectric unions at all connections of dissimilar metals.

PART 2 - PRODUCTS

2.1 COPPER PIPE

- A. Copper pipe to be of type and thickness as specified in Section 232113. Fittings shall be wrought copper fittings with soldered ends designed for 150 psi (steam) and 300 psi (water) pressure. All joints and fittings shall comply with the latest edition of ASME code for pressure piping. 2-1/2 inches and larger equipment and valved connections shall be flanged.
- B. In domestic water piping, all soldered joints shall be made with lead-free nickel silver solder for 150 psi, 250 deg F.

2.2 BLACK STEEL PIPE

- A. Steel pipe to be of type specified in Section 232113. For welded piping 1-1/2 inches and smaller, pipe shall be butt welded steel. Larger pipe shall be seamless steel or electric resistance welded. Pipe thickness shall be as scheduled in the specifications. All joints and fittings shall comply with the latest edition of ASME code for pressure piping.
- B. Threaded pipe shall be accurately cut NPT tapered right hand threads. Screwed fittings shall be of the same make and thickness for weight as the pipe used.
- C. Butt weld pipe joints shall be butt type, single vee made by fusion welding oxy-acetylene, electric welding using high test welding rod or semi-automatic metal arc welding machines using micro-wire. Branches in straight pipe are to be made with welding tees of same make and thickness of weight as the pipe used. Branches 1/4 the size of the main or less may be made with weld neck flanges, weld-o-let=s or thread-o-let fittings. Elbows shall be long radius.

- D. Socket weld pipe joints shall be made using 2000 lb. socket weld steel fittings. All other items shall be per part 2.2, paragraph C this section of specifications.
- E. Flanged pipe: Connections to valves, equipment, etc. shall be made with 125 - 150 lb. standard flanges, except for 250 - 300 lb. extra heavy flanges or fitting on valves, equipment, etc. furnished with extra heavy flanges. Flanged joints are to be faced square and true.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Each union or flange be installed to permit east removal of parts and equipment, and in a position permitting the device or equipment to be removed without disconnecting piping. Connections to equipment shall be arranged to facilitate ease of removal and service without dismantling of the run-outs of main piping, and shall be installed by the use of multiple elbows or other similar methods to minimize strain on the equipment connections.
- B. Make reductions in piping lines with reducing coupling or weld fitting reducer.
- C. Install piping to provide clearance for personnel passage, headroom, operation of doors or windows, equipment, lighting outlets, or with Owner's apparatus and equipment.
- E. In pipe spaces to be entered for servicing, piping shall be offset so that all lateral runs are located either near floor or 6'-0" above floor and all vertical piping is held close to the wall through that height. Keep all piping to side of chase wherever possible.
- E. Piping containing liquids shall not be installed over electrical equipment.
- F. Install pipes, valves, fittings, etc. to be insulated with a minimum of 1/2-inch clearance between the finished covering and other work and between the finished covering of parallel, adjacent pipes.
- G. Make changes in pipe line direction with fittings only.
- H. Offset lines around columns, beams and other obstructions as required. Where special conditions are encountered in field, arrangement and alignment of piping shall be decided by the Owner's Representative.
- I. At time of erection, piping components shall be cleaned of loose material. After erection, and prior to putting in service, lines shall be blown or flushed free of loose materials. Clean strainer screens and sediment pockets prior to putting lines in service.
- J. Install valves at service connections to equipment and branch lines from main lines. All valves and unions to be installed so as to be accessible through ceiling or wall access panel.
- K. Contractor is responsible for conformance with all applicable requirements for welding and burning. Contractor shall obtain all necessary permits.
- L. SECURELY SUPPORT all piping from structure with approved hangers, rods, brackets and accessories.
- M. Where piping is installed in new masonry block walls, coordinate with General Contractor so piping extends out through a masonry joint where possible.
- N. Bullhead fittings are not allowed.

- O. Where exposed pipes pass through walls, floors or ceilings of finished rooms, provide chrome-plated escutcheons. Prime-coated black iron escutcheons may be used in unfinished rooms. Protect escutcheons from tool marks.
- P. Keep pipe level except where a slope is required. Use eccentric reducers to keep top of pipe level.
- Q. Avoid trapping of piping.
- R. Use transition fittings as recommended by manufacturers to change from one pipe material or type to another.
- S. All new piping during the installation period shall have openings protected with temporary caps or protective covers as required to keep the inside of the piping system clean from all dirt, debris and foreign material.
- T. At completion of project, thoroughly flush each of the various HVAC hydronic circulating systems with a cleaning solution as recommended by the chemical supplier and the various material manufacturers, so as to remove any oil, rust, dirt, scale or grease that may be present.
- U. Do not obstruct passageways, headroom, door and window operation, and similar areas with the installation of piping.

3.2 PIPING PROHIBITIONS

- A. Contractor shall not run piping over electrical panels, across windows, door openings, access panels, lighting fixture or within 36 inches in front of electrical panels. Obtain instructions from the Architect if a conflict occurs.
- B. On any given system, the Contractor will not be permitted to mix and joint different types of pipe material. For example, if a hot water heating system uses copper and steel, the Contractor may change from one to the other only once, the line may not be changed back to the first material further downstream.
- C. Drain lines shall be continuously sloped; trapping is expressly prohibited.

END OF SECTION 230515

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SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

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.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 STACK-SLEEVE FITTINGS

- 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. Smith, Jay R. Mfg. Co.
 - 2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.3 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. CALPICO, Inc.
 - 3. Metraflex Company (The).
 - 4. Pipeline Seal and Insulator, Inc.
 - 5. Proco Products, 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.

2.4 SLEEVE-SEAL FITTINGS

- 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 product indicated on Drawings or comparable product by one of the following:
 - 1. Presealed Systems.
- C. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
- D. Cut sleeves to length for mounting flush with both surfaces.
 - 1. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- E. 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 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 Division 07 Section "Joint Sealants."
- F. 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 Division 07 Section "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 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.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves, Galvanized-steel wall sleeves, or Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Cast-iron wall sleeves, Galvanized-steel wall sleeves, or Galvanized-steel-pipe sleeves.
 - 2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system, Galvanized-steel wall sleeves with sleeve-seal system, or Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system, Galvanized-steel wall sleeves with sleeve-seal system, or Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6 Galvanized-steel-pipe sleeves, Stack-sleeve fittings, Sleeve-seal fittings
 - b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves, Stack-sleeve fittings.
4. Interior Partitions:
 - a. Piping Smaller Than NPS 6 Galvanized-steel-pipe sleeves,
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 230517

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SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

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. Escutcheons.
 - 2. Floor plates.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With rough brass finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With rough-brass finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- 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. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
 - c. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with rough brass finish.
 - d. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
 - e. Bare Piping in Equipment Rooms: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
 - 2. Escutcheons for Existing Piping:
 - a. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
 - b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with rough brass finish.
 - c. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with rough brass finish.
 - d. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge.
 - e. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with concealed hinge.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 230518

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SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following meters and gages for mechanical systems:
 - 1. Test plugs.

1.2 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated; include performance curves.
- B. Shop Drawings: Schedule for thermometers and gages indicating manufacturer's number, scale range, and location for each.

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 (1) of the manufacturers specified.

2.2 TEST PLUGS

- A. Manufacturers:
 - 1. Peterson Equipment Co., Inc.
 - 2. Sisco Manufacturing Co.
 - 3. Trerice, H. O. Co.
 - 4. Watts Industries, Inc.; Water Products Div.
- B. Description: 1/2 inch NPT, Corrosion-resistant brass body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.
- C. Minimum Pressure and Temperature Rating: 1000 psi at 350 deg F.
- D. Core Inserts: Two (2) self-sealing rubber valves.
 - 1. Insert material for air, water, oil, or gas service at 20 to 350 deg F shall be Nordel.

- E. Test Kit: Furnish one (1) test kit containing one (1) pressure gage and adaptor, two (2) thermometers, and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.
 - 1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3- inch diameter dial and probe. Dial range shall be 0 to 200 psig.
 - 2. Low Range Thermometer: Small bimetallic insertion type with 2 inch diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
 - 3. Carrying case shall have formed instrument padding.

PART 3 - EXECUTION

3.1 TEST PLUG APPLICATIONS

- A. Inlet and outlet of each heating and cooling coil.
- B. Inlet and outlet of each strainer on coils.
- C. Inlet and outlet of each temperature regulating valve.
- D. Inlet and outlet of each pressure reducing valve.
- E. Both inlets to differential pressure transmitters.

3.2 INSTALLATIONS

- A. Install test plugs in tees in piping. Install test plugs with sufficient clearance to permit installation of test gauges and thermometers.

3.3 CONNECTIONS

- A. Install test plugs adjacent to machines and equipment to allow service and maintenance for meters, gages, machines and equipment.

3.4 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 230519

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SECTION 230523 – GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide valves to facilitate maintenance and isolation of piping systems.

1.2 QUALITY ASSURANCE

A. STANDARDS

1. American National Standards Institute (ANSI), American Society of Mechanical Engineers (ASME), American Society for Testing and Materials (ASTM) and the Manufacturers' Standardization Society of the Valve and Fittings Industry (MSS).
2. ANSI B16.10, MSS SP0-67-90 Butterfly Valves.
3. MSS SP-70-90 Cast Iron Gate Valves, Flanged or Threaded Ends.
4. MSS SP-78-92 Cast Iron Plug Valves Flanged and Threaded.
5. MSS SP-80-87 Bronze Gate, Globe, and Check Valves.
6. MSS SP-85-85 Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.
7. MSS SP-110-92 Ball Valves Threaded, Socket-Welded, Solder Joint, Grooved and Flared Ends.

- B. To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by the same manufacturer.

1.3 DEFINITIONS

A. The following are standard abbreviations for valves:

1. CWP: Cold working pressure.
2. EPDM: Ethylene-propylene-diene terpolymer rubber.
3. NBR: Acrylonitrile-butadiene rubber.
4. PTFE: Polytetrafluoroethylene plastic.
5. OS & Y: Outside screw and yoke.
6. RS: Rising stem.
7. SWP: Steam working pressure.
8. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

- A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle, gate, and globe valves closed to prevent rattling.
 - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
 - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use hand wheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. All similar valves used on the project shall be by the same manufacturer.
- B. 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 (1) of the manufacturers specified.

2.2 VALVES, GENERAL

- A. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- B. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- C. Valve Actuators:
 - 1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.

2. Gear Drive: For quarter-turn valves NPS 6 and larger and on discharge of all pumps without VFD=s.
 3. Handwheel: For valves other than quarter-turn types.
 4. Lever Handle: For quarter-turn valves NPS 5 and smaller, except plug valves.
 5. Wrench: For plug valves with square heads. Furnish Owner with one (1) wrench for every ten (10) plug valves, for each size square plug head.
- D. Extended Valve Stems: On insulated valves.
- E. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves and ASME B16.24 for bronze valves.
- F. Valve Grooved Ends: AWWA C606.
- G. Solder Joint: With sockets according to ASME B16.18. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.
- H. Threaded Joint: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.

2.3 BALL VALVES (2-1/2 INCHES AND SMALLER)

- A. 400 psi WOG, 150 psi steam, bubble-tight against 100 psi, cast bronze body, self-aligning free floating stainless steel ball and stem with full flow port, non-rising stem, Teflon seat and body seal, quarter turn operation, solder joint or screwed ends. Valves to include memory stop and stem extensions for insulated piping.
1. Drain valves with hose fitting, dust cover and chain attachment: Apollo No. 78-144
 2. All other valves: Apollo No. 77-140/240
 3. Manufacturers:
 - a. Apollo (Basis of Design)
 - b. Hammond
 - c. Milwaukee
 - d. Nibco
 - e. Watts
 - f. Victaulic Co. of America
- B. Two-Piece Standard Port Ductile Iron Ball Valve, (Sizes 2 inch to 2-1/2 inch):
1. Manufacturer:
 - a. Victaulic Company Series 726

2. Description:
 - a. Standard: MSS SP-72.
 - b. CWP Rating: 800 psig
 - c. Body Material: ASTM A 536 Ductile Iron
 - d. Ends: Grooved.
 - e. Seats: TFE.
 - f. Stem: Stainless steel.
 - g. Ball: Stainless Steel.
 - h. Port: Full port to match pipe size.

2.4 BUTTERFLY VALVES (3 INCHES AND LARGER)

- A. 225 psi line pressure, bubble-tight bi-directionally against 225 psi differential pressure, 250 psi dead end pressure, cast iron lugged type body, double-seated, stainless steel disc, with EPDM seat, stainless steel shaft, bronze bushings, 200° F maximum water temperature.
 1. 12 inches and smaller: Keystone Fig. 22
 2. 14 inches and larger : Keystone Fig. AR2
- B. Manufacturers:
 1. DeZurik
 2. Keystone (Basis of Design)
 3. Milwaukee
 4. Nibco
 5. Norris
 6. Watts

2.5 CALIBRATED BALANCING VALVES

- A. Bell & Gossett Circuit Setter Plus or equal by Armstrong, Taco, Tour & Andersson, Flowset with positive shut-off, memory stop screw or 4-turn digital readout handwheel, drain connection, read-out valves with EPT insert and check valve, insulated cover, bronze or Ametal brass body, brass ball or globe type, carbon filled TFE or Ametal seats, calibrated name plate. Balancing valves to be 30 PSIT/250 Deg, F rated for 1/2" to 3" NPT connections, 200 PSIG/250 Deg, F rated for 1/2" to 3/4" sweat or grooved connections and 125 PSIG/250 Deg, F rated for 4" flanged or grooved connections.
- B. Furnish a portable flow measuring instrument for verifying and determining flow. Furnish carrying case, gage, valve block and color coded hoses for low and high pressure connections, and connectors for connection to read-out valves.

2.6 CHAINWHEEL ACTUATORS

- A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - 1. Sprocket Rim with Chain Guides: Cast iron, of type and size required for valve.
 - 2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 3. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- F. Examine grooved ends for conditions that might cause leakage. Ends should be free from indentations or projections in the area from the valve end to the groove.
- G. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

- A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball valves for size 2-1/2" and less; butterfly valves for sizes 3" and larger.
 - 2. Throttling Service: Ball valves for size 2-1/2" and less; butterfly valves for sizes 3" and larger.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

3.3 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions, grooved couplings or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.

- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full stem movement.
- F. Install chain wheel operators on valves NPS 3 and larger and more than 96 inches above floor. Extend chains to 78 inches above finished floor elevation.
- G. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
 - 3. Lift Check Valves: With stem upright and plumb.
- H. Provide sufficient space to allow adjustment of balancing valves.
- I. Install drain valves in piping at low points and trapped areas to provide complete drainage of all systems.

3.4 JOINT CONSTRUCTION

- A. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated. Open valves before soldering.

3.5 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.

END OF SECTION 230523

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SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes hangers and supports for mechanical system equipment.

1.2 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

1.4 SUBMITTALS

- A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer for multiple piping supports and trapeze hangers. Include design calculations and indicate size and characteristics of components and fabrication details.
- C. Welding Certificates: Copies of certificates for welding procedures and operators.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the manufacturers specified:
 - 1. Channel Support Systems:
 - a. Grinnell Corp.; Power-Strut Unit.
 - b. Michigan Hanger Co., Inc.; O-Strut Div.
 - c. National Pipe Hanger Corp.
 - d. Thomas & Betts Corp.
 - e. Unistrut Corp.

2. Thermal-Hanger Shield Inserts:
 - a. Michigan Hanger Co., Inc
 - b. Pipe Shields, Inc.
 - c. Rilco Manufacturing Co., Inc.
 - d. Value Engineered Products, Inc.
3. Powder-Actuated Fastener Systems:
 - a. Gunnebo Fastening Corp.
 - b. Hilti, Inc.
 - c. ITW Ramset/Red Head.
 - d. Masterset Fastening Systems, Inc.

2.2 MANUFACTURED UNITS

- A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.
 1. Galvanized, Metallic Coatings: For piping and equipment that will not have field-applied finish.
 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
 1. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- C. Thermal-Hanger Shield Inserts: 100 psi minimum compressive-strength insulation, encased in sheet metal shield.
 1. Material for Cold Piping: ASTM C 552, Type I cellular glass with vapor barrier.
 2. Material for Hot Piping: ASTM C 552, Type I cellular glass.
 3. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
 4. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
 5. Insert Length: Extend 2" beyond sheet metal shield for piping operating below ambient air temperature.

2.3 MISCELLANEOUS MATERIALS

- A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported

loads and building materials where used.

- C. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.
- D. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
 - 1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
 - 2. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 3. Design Mix: 5000-psi 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger requirements are specified in Sections specifying equipment and systems.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.3 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes 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 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 contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.5 PAINTING

- A. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 230529

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SECTION 230548 - VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Elastomeric isolation pads.
 - 2. Freestanding and restrained spring isolators.
 - 3. Housed spring mounts.
 - 4. Elastomeric hangers.
 - 5. Spring hangers.

1.2 SUBMITTALS

- A. Product Data: Include load deflection curves for each vibration isolation device.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the manufacturers specified.
 - 1. Amber/Booth Company, Inc.
 - 2. Kinetics Noise Control, Inc.
 - 3. Mason Industries, Inc.
 - 4. Vibration Eliminator Co., Inc.
 - 5. Vibration Mountings & Controls/Korfund.
- B. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
 - 1. Material: Standard neoprene.
- C. Elastomeric Mounts: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-Code or otherwise identify to indicate capacity range.
- D. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
 - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 3. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 100 psig.
 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- E. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4 inch thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 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 the rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- F. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.
1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
 2. Base: Factory drilled for bolting to structure.
 3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel before contacting a resilient collar.
 4. Static deflection: 2 inches.
- G. Elastomeric Hangers: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range. Static deflection: 0.5 inches.
- H. Spring Hangers: 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 the 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.

2.2 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be electro-galvanized. Hot-dip galvanized metal components for exterior use.
 - 3. Baked enamel for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Provide vibration isolators for equipment and piping as indicated on the design drawings and as required by other sections of Division 23.
- B. Install steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe hangers. At trapeze anchor locations, shackle piping to trapeze. Requirements apply equally to hanging equipment. Do not weld angles to rods.
- C. Install resilient bolt isolation washers on equipment anchor bolts.

3.3 QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
 - 1. Isolator deflection.
 - 2. Snubber minimum clearances.

3.4 ADJUSTING

- A. Adjust isolators after piping systems have been filled and equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust snubbers according to manufacturer=s written recommendations.
- D. Torque anchor bolts according to equipment manufacturer=s written recommendations to resist seismic forces.

3.5 CLEANING

- A. After completing equipment installation, inspect vibration isolation devices. Remove paint splatters and other spots, dirt, and debris.

END OF SECTION 230548

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SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. IDENTIFY BY LABELS AND TAGS THE FOLLOWING ITEMS
 - 1. Equipment such as exhaust fans, air handling units, control cabinets, VAV boxes, etc.
 - 2. Piping, valves and ductwork exposed in equipment rooms and accessible service areas.
 - 3. Piping, valves and ductwork running above accessible ceiling construction and near access panels in non-accessible construction areas.
 - 4. All temperature control valves and automatic control dampers.
- B. Install laminated plastic markers and metal stamped nameplates for equipment. Provide color banding, flow arrows and contents identification for piping and ductwork.

1.2 SUMMARY

- A. This Section includes the following mechanical identification materials and their installation:
 - 1. Equipment nameplates.
 - 2. Equipment markers.
 - 3. Pipe markers.
 - 4. Duct markers.
 - 5. Stencils.
 - 6. Valve tags.
 - 7. Valve Schedules.
 - 8. Warning tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Valve numbering scheme.
- D. Valve Schedules: For each piping system. Furnish three extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors and viewing angles of identification devices for piping.

1.5 COORDINATION

- A. Coordination 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 location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. All trades shall use the same type, style and appearance of identification.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
 - 1. Data:
 - a. Manufacturer, product name, model number, and serial number.
 - b. Capacity, operating and power characteristics, and essential data.
 - c. Labels of tested compliances.
 - 2. Location: Accessible and visible.
 - 3. Fasteners: As required to mount on equipment.
- B. Equipment Markers: Engraved, laminated plastic, white lettering on black background. Markers shall be screw on, except where screws might damage equipment, use a contact-type permanent adhesive.
 - 1. Terminology: Match schedules as closely as possible.
 - 2. Size: Sized for 3/4-inch lettering.

2.2 PIPING IDENTIFICATION DEVICES

- A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
 - 1. Colors: As indicated in specification schedule.
 - 2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 - 3. Pipes with OD, including insulation, less than 6 inches: Full-band pipe markers extending 360 degrees around pipe at each location.
 - 4. Pipes with OD, including insulation, 6 inches and larger: Either full-band or strip-type pipe markers at least three (3) times letter height and of length required for label.

5. Arrows: A separate unit on each pipe marker to indicate direction of flow.

2.3 DUCT IDENTIFICATION DEVICES

- A. Stencils: Prepared with minimum letter height of 1-1/4 inches for ducts.
 1. Stencil Paint: Exterior, gloss, alkyd enamel black, unless otherwise indicated. Paint may be in pressurized spray-can form.
 2. Identification Paint: Exterior alkyd enamel in colors as indicated in specification schedule.
- B. Manual dampers: Wrap duct with red plastic ribbon with 12" long tail at each manual damper.

2.4 VALVE TAGS

- A. Valve Tags: 2" diameter tag stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme, approved by Engineer. Provide 5/32-inch hole for fastener.
 1. Material: 16 gauge brass.
 2. Valve-Tag Fasteners: Brass beaded chain.

2.5 VALVE SCHEDULES

- A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulation), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
 2. Frame: Extruded aluminum.
 3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.6 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
 1. Size: Approximately 4 by 7 inches.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other Division 15 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.
- B. Installing Contractor is responsible for valve tagging, equipment markers and pipe identification of all valves, equipment and piping on packaged pumping skids.

3.2 EQUIPMENT IDENTIFICATION

- A. Install equipment markers with screws, or, if screws might damage equipment, use permanent adhesive on or near each major item of mechanical equipment.
 - 1. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
 - a. Main control and operating valves, including safety devices.
 - b. Coils, heat recovery units and similar equipment.
 - c. Fans, blowers, primary balancing dampers, and mixing boxes.
 - d. Energy recovery units.

3.3 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service of each piping system. Install with flow indication arrows showing direction of flow.
- B. All underground pipe shall be marked with a continuous, underground-type plastic line marker. Confirm location of markers with the Engineer.
- C. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed 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 through walls, floors, ceilings, and non-accessible 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 along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings.

D. Pipe Identification:

<u>TYPE OF SERVICE</u>	<u>1" BAND COLOR</u>	<u>½" BAND COLOR</u>	<u>DESIGNATION</u>
Dual Temp. Supply	Blue	Lime Green	DTS
Dual Temp. Return	Blue	Lime Green	DTR

3.4 DUCT IDENTIFICATION

- A. Stenciled Duct Markers: Stenciled markers, showing service and direction of flow. Stencil only after ductwork is painted.
- B. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system and at access doors in concealed spaces.
- C. Duct Identification:

<u>TYPE OF SERVICE</u>	<u>1" BAND COLOR</u>	<u>DESIGNATION</u>
Supply Air	Green	SUPPLY
Return Air	Blue	RETURN
Exhaust Air	Blue	EXH
Outdoor Air	Blue	OA

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves with captions as indicated in the following:

<u>TYPE OF SERVICE</u>	<u>VALVE TAG DESIGNATION</u>
Dual Temperature Supply	DTS
Dual Temperature Return	DTR

3.6 VALVE-SCHEDULE INSTALLATION

- A. Mount valve schedule on wall in accessible location where directed by Owner. Provide aluminum frame with plexiglass cover for valve chart.

3.7 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to equipment and other items where required.

3.8 ADJUSTING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work. Stencils, name tags, etc. must be readable from a standing position.
- B. When arrows and letters cannot be stenciled on pipe, stencil identification on 16 gauge aluminum metal panels in correct color and hang panel on piping with key chains.

3.9 CLEANING

- A. Clean faces of mechanical identification devices and glass and frames of valve schedules.

END OF SECTION 230553

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SECTION 230593 - TESTING ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. The testing, adjusting and balancing work as specified in this section is to be performed by a certified balancing contractor that is hired by the HVAC Contractor. All final tab work will be completed at the end of the final phase of work. The HVAC Contractor is to provide all necessary assistance and coordination with the testing, adjusting and balancing, (TAB) contractor as required to complete the balancing work and generate the balancing report as specified in this section. The HVAC Contractor is to provide all system start-up procedures and commissioning tasks that are required prior to balancing work as specified in the other sections of this specification.
- B. This Section includes testing, adjusting and balancing to produce design objectives for the following:
 - 1. Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
 - 2. Hydronic Piping Systems:
 - a. Dual Temperature water systems.
 - 3. HVAC equipment quantitative-performance settings.
 - 4. Verifying that automatic control devices are functioning properly.
 - 5. Reporting results of activities and procedures specified in this Section.
 - 6. In general, the Balancing Work will occur at the end of the last phase of this project.

1.2 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including sub-mains, branches, and terminals, according to indicated quantities.
- C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
- D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- E. NC: Noise criteria.
- F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- G. RC: Room criteria.
- H. Report Forms: Test data sheets for recording test data in logical order.

- I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- M. TAB: Testing, adjusting, and balancing.
- N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- O. Test: A procedure to determine quantitative performance of systems or equipment.
- P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.3 SUBMITTALS

- A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit two (2) copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days from Contractor's Notice to Proceed, submit two (2) copies of the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 90 days from Contractor's Notice to Proceed, submit two (2) copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.
- D. Certified TAB Reports: Submit two (2) copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
- E. Sample Report Forms: Submit two (2) sets of sample TAB report forms.
- F. Warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.
- B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven (7) days' advance notice of scheduled meeting time and location.
 - 1. Agenda Items: Include at least the following:
 - a. Submittal distribution requirements.
 - b. The Contract Documents examination report.
 - c. TAB plan.
 - d. Work schedule and Project-site access requirements.
 - e. Coordination and cooperation of trades and subcontractors.

- f. Coordination of documentation and communication flow.
- C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing", or TAB firm's forms approved by Engineer.
- E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."
- F. Instrumentation Calibration: Calibrate instruments at least every six (6) months or more frequently if required by instrument manufacturer.
 - 1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.5 PROJECT CONDITIONS

- A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.6 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Notice: Provide seven (7) days' advance notice for each test. Include scheduled test dates and times.
- C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.7 WARRANTY

- A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents or provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:
 - 1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
 - 2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 – PRODUCTS (NOT USED)

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.
 - 1. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."
- 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 equipment performance data including fan and pump curves. 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. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
- F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- G. Examine system and equipment test reports.
- H. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- I. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- J. Examine fan coil units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.
- K. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.
- L. Examine strainers for clean screens and proper perforations.
- 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 equipment for installation and for properly operating safety interlocks and controls.
- P. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices are operated by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in variable-air-volume terminals.

4. Automatic modulating and shutoff valves, including two-way valves, are properly connected.
 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 6. Sensors are located to sense only the intended conditions.
 7. Sequence of operation for control modes is according to the Contract Documents.
 8. Controller set points are set at indicated values.
 9. Interlocked systems are operating.
 10. Changeover from heating to cooling mode occurs according to indicated values.
- Q. 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.
- B. Complete system readiness checks and prepare system readiness reports. Verify the following:
 1. Permanent electrical power wiring is complete.
 2. Hydronic systems are filled, clean, and free of air.
 3. Automatic temperature control systems are operational.
 4. Equipment and duct access doors are securely closed.
 5. Balance and fire dampers are open.
 6. Isolating and balancing valves are open and control valves are operational.
 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, 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 outside-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. Check for proper sealing of air duct system.

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 fan static pressures to determine actual static pressure as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 2. Measure static pressure across each component that makes up a rooftop unit.
 - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
 - 3. Measure static pressures entering and leaving other devices such as sound traps and heat recovery equipment, under final balanced conditions.
 - 4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.

5. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, belt, sheaves, motor sizes, and electrical connections to accommodate fan-speed changes including changing of belts, pulleys and sheaves.
 6. 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 will occur. Measure amperage in; full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, sub-main ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
 - a. Where sufficient space in sub-main and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Re-measure each sub-main and branch duct after all have been adjusted. Continue to adjust sub-main and branch ducts to indicated airflows within specified tolerances.
- C. Measure terminal outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pup flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 1. Open all manual valves for maximum flow.
 2. Check expansion tank liquid level.
 3. Check makeup-water station pressure gage for adequate pressure for highest vent.
 4. Check flow-control valves for specified sequence of operation and set at indicated flow.
 5. Set differential-pressure control valves at the specified differential pressure.
 6. Set system controls so automatic valves are wide open to heat exchangers.

7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.
9. Check ethylene glycol percent by volume in chilled water system.

3.7 PROCEDURES FOR HYDRONIC SYSTEMS

- A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:
 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 4. Report flow rates that are not within plus or minus 5% of design.
- B. Verify flow rate through automatic flow control valves
- C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
- D. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- E. Measuring the differential-pressure control valve settings existing at the conclusions of balancing.

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.

3.9 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

- A. Balance the primary circuit flow first and then balance the secondary circuits.

3.10 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 1. Manufacturer, model, and serial numbers.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Efficiency rating.

5. Nameplate measured voltage and amperage for each phase.
 6. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Record observations, including: controller manufacturer, model and serial numbers, and nameplate data.

3.11 PROCEDURES FOR HEAT TRANSFER COILS

- A. Water Coils: Measure the following data for each coil:
1. Entering and leaving water temperature.
 2. Water flow rate.
 3. Water pressure drop
 4. Dry-bulb temperature of entering and leaving air.
 5. Wet-bulb temperature of entering and leaving air for cooling coils.
 6. Airflow.
 7. Air pressure drop.

3.12 PROCEDURES FOR TEMPERATURE MEASUREMENTS

- A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure indoor wet and dry bulb temperatures every other hour for a period of two (2) successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
- C. Measure outside air, wet and dry-bulb temperatures.

3.13 TEMPERATURE-CONTROL VERIFICATION

- A. Verify that controllers are calibrated and commissioned.
- B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- C. Record controller settings and note variances between set points and actual measurements.
- D. Check the operation of limiting controllers (i.e., high and low temperature controllers).
- E. Check free travel and proper operation of control devices such as damper and valve operators.
- F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.
- G. Check the interaction of electrically operated switch transducers.
- H. Check the interaction of interlock and lockout systems.

- I. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or non-grounded power supply.
- J. Note operation of electric actuators using spring return for proper fail-safe operations.

3.14 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 - 1. Supply, Return, and exhaust Fans and Equipment with Fans: Plus 5% to plus 10%.
 - 2. Air Outlets and Inlets: 0 to minus 10%.
 - 3. Heating-Water Flow Rate: 0 to minus 10%.
 - 4. Cooling-Water Flow Rate: 0 to minus 5%.

3.15 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system.

3.16 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. 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, but do not include Shop Drawings and Product Data.

- D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
1. Title page.
 2. Name and address of TAB firm.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB firm 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, type size, and fittings.
 14. Notes to explain why certain final data in the body of reports varies from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outside, 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. Settings for supply air, static pressure controller.
 - g. Other system operating conditions that affect performance.

- E. 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.
 6. Balancing stations.
 7. Position of balancing devices.
- F. Energy Recovery Unit Test Reports: For energy recovery units with coils, include the following:
1. Unit Data: Include the following:
 - 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, and bore.
 - i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - j. Number of belts, make, and size.
 - k. Number of filters, type, and size.
 2. Motor Data:
 - a. 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, and bore.
 - f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
- a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static pressure differential in inches wg.
 - f. Energy wheel static pressure differential in inches wg.
 - g. Cooling coil static pressure differential in inches wg.
 - h. Outside airflow in cfm.
 - i. Energy airflow in cfm.
 - j. Outside air damper position.
 - k. Energy air damper position.

G. 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 o.c.
 - f. Make and model number.
 - g. Face area in sq. ft.
 - h. Tube size in NPS.
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
- 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Average face velocity in fpm.

- c. Air pressure drop in inches wg.
 - d. Outside air, wet and dry bulb temperatures in deg F.
 - e. Exhaust air, wet and dry bulb temperatures in deg F.
 - f. Entering air, wet and dry bulb temperatures in deg F.
 - g. Leaving air, wet and dry bulb temperatures in deg F.
- H. Fan Test Reports: For supply 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, and bore.
 - h. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - 2. Motor Data:
 - a. 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, and bore.
 - f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - g. Number of belts, make, and size.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.

- I. Round 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. Duct static pressure in inches wg.
 - d. Duct size in inches.
 - e. Duct area in sq. ft.
 - f. Indicated airflow rate in cfm.
 - g. Indicated velocity in fpm.
 - h. Actual airflow rate in cfm.
 - i. Actual average velocity in fpm.
- J. Fan Coil Units Device Reports:
 1. Unit Data:
 - a. System identification.
 - b. Location and zone.
 - c. Test apparatus used.
 - d. Area served.
 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.

K. System-Coil Reports: For water coils of fan coil units, include the following:

1. Unit Data:
 - a. System 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.
 - b. Entering water temperature in deg F.
 - c. Leaving water temperature in deg. F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering air temperature in deg F.
 - f. Leaving air temperature in deg F.

L. Pump Test Reports:

1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model and serial numbers.
 - f. Water flow rate in gpm.
 - g. Water pressure differential in feet of head or psig.
 - h. Required net positive suction head in feet of head or psig.
 - i. Pump rpm.
 - j. Impeller diameter in inches.
 - 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.
 - b. Pump shutoff pressure in feet of head or psig.
 - c. Actual impeller size in inches.
 - d. Full open flow rate in gpm.
 - e. Full open pressure in feet of head or psig.
 - f. Final discharge pressure in feet of head or psig.
 - g. Final suction pressure in feet of head or psig.
 - h. Final total pressure in feet of head or psig.
 - i. Final water flow rate in gpm.
 - j. Voltage at each connection.
 - k. Amperage for each phase.
- M. Air to Air Heat-Recovery Unit Reports:
1. Unit Data:
- a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and type.
 - e. Model and serial numbers.
2. Test Data (Indicated and Actual Values):
- a. Total exhaust airflow rate in cfm.
 - b. Outside airflow rate in cfm.
 - c. Total exhaust fan static pressure in inches wg.
 - d. Total outside air fan static pressure in inches wg.
 - e. Pressure drop on each side of heat exchanger in inches wg.

- f. Exhaust air temperature humidity entering in deg F and % RH.
- g. Exhaust air temperature humidity leaving in deg F and % RH.
- h. Outside air temperature humidity entering in deg F and % RH.
- i. Outside air temperature humidity leaving in deg F and % RH.
- j. Calculate sensible and total heat capacity of each airstream in MBh

N. Combustion Test:

1. Unit Data

- a. Boiler manufacturer.
- b. Model number.
- c. Serial number.
- d. Firing rate.
- e. Overfire draft
- f. Gas meter timing dial size.
- g. Gas meter time per revolution.
- h. Gas pressure at meter outlet.
- i. Gas flow rate.
- j. Heat input.
- k. Burner manifold gas pressure.
- l. Percent carbon monoxide (CO).
- m. Percent carbon dioxide (CO₂).
- n. Percent oxygen (O₂).
- o. Percent excess air.
- p. Flue gas temperature at outlet.
- q. Ambient temperature.
- r. Net stack temperature.
- s. Percent stack loss.
- t. Percent combustion efficiency.
- u. Heat output.

O. Instrument Calibration Reports:

1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.17 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
2. Randomly check the following for each system:
 - a. Measure airflow of at least 10% of air outlets.
 - b. Measure water flow of at least 5% of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor.

Compare the reading to the set point.
 - d. Verify that balancing devices are marked with final balance position.
 - e. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Architect.
3. Architect shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10% of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8 hour business day.
4. If the 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."
5. If the number of "FAILED" measurements is greater than 10% of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.

7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.18 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional testing and balancing 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 testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 230593

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SECTION 230700 - PIPE INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes preformed, rigid and flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

1.2 SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details for the following:
 - 1. Application of protective shields, saddles, and inserts at pipe hangers for each type of insulation and hanger.
 - 2. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 3. Removable insulation at piping specialties and equipment connections.
 - 4. Application of field-applied jackets.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
- C. ASHRAE Standards: Comply with performance efficiencies prescribed for ASHRAE 90.1, "Energy Efficient Design for New Buildings, Except Low Rise Residential Buildings" for pipe insulation.
- D. No damaged or water soaked insulation shall be used.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.5 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields.
- B. Coordinate clearance requirements with piping installer for insulation application.

1.6 SCHEDULING

- A. Schedule insulation application after testing piping systems. Insulation application may begin on segments of piping that have satisfactory test results.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the manufacturers specified.
 - 1. Mineral-Fiber Insulation:
 - a. CertainTeed Manson.
 - b. Knauf FiberGlass GmbH.
 - c. Owens-Corning Fiberglas Corp.
 - d. Schuller International, Inc.
 - e. Armacell

2.2 INSULATION MATERIALS

- A. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:
 - 1. Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket.
 - 2. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
 - a. Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
 - b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.
 - 3. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
 - 4. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.
 - 5. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
- B. Cellular-Glass Insulation: Foamed glass, annealed, rigid, hermetically sealed cells, incombustible. Preformed Pipe Insulation, with Jacket: Comply with ASTM C 552, Type II, Class 2.
- C. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - 1. Adhesive: As recommended by insulation material manufacturer.

- D. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves.

2.3 FIELD APPLIED JACKETS

- A. General: ASTM C 921, Type 1, unless otherwise indicated.
- B. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil thick, high-impact, ultraviolet-resistant PVC.
 - 1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps and mechanical joints.
 - 2. Adhesive: As recommended by insulation material manufacturer.
- C. PVC Jacket: High-impact-resistant, UV resistant PVC complying with ASTM D1784, Class 16354-C; 30 mils thick; roll stock ready for shop or field cutting and forming. Finish color to be white.
- D. Aluminum Jacket: Aluminum roll stock, ready for shop or field cutting and forming to indicated sizes. Comply with ASTM B 209, 3003 alloy, H-14 temper
 - 1. Finish and Thickness: Stucco-embossed finish, 0.020-inch thick.
 - 2. Moisture Barrier: 1-mil thick, heat-bonded polyethylene and kraft paper.
 - 3. Elbows: Preformed, 45- and 90-degree, short- and long-radius elbows; same material, finish, and thickness as jacket.
- E. Glass Cloth Covering: Self-adhesive, mastic impregnated, rewettable cloth.
 - 1. Thickness: 0.028 inches
 - 2. Maximum Service Temperature: 450 degrees F.
 - 3. Density: 14.3 oz/sq yd
 - 4. Surface Burning Characteristic: 25/50 per ASTM E84

2.4 ACCESSORIES AND ATTACHMENTS

- A. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:
 - 1. Aluminum: 0.007 inch thick.
- B. Wire: 0.080 inch, nickel-copper alloy; 0.062 inch, soft-annealed, stainless steel; or 0.062 inch soft-annealed, galvanized steel.
- C. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave presized a minimum of 14.3 oz./sq. yd.
 - 1. Tape Width: 4 inches.

2.5 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.
- E. Apply 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. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- H. Keep insulation materials dry during application and finishing.
- I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- J. Apply insulation with the least number of joints practical.
- K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.
- L. Hangers and Anchors:
 - 1. Apply insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12

inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.
- M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.
- O. Apply insulation with integral jackets as follows:
1. Pull jacket tight and smooth.
 2. Circumferential Joints: Cover with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
 3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply 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 o.c.
 - a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.
 4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
 5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.
- P. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.
- Q. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.
- R. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.
1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Firestopping."
- S. Floor Penetrations: Apply insulation continuously through floor assembly.
1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.
- 3.4 MINERAL-FIBER INSULATION APPLICATION
- A. Apply insulation to straight pipes and tubes as follows:
1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.
 2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic.

Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet to form a vapor retarder between pipe insulation segments.

3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches on center.
4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
5. All exposed ends for mineral fiber insulation shall be neatly trimmed and beveled. All exposed insulation material shall be covered with mastic.

B. Apply insulation to flanges as follows:

1. Apply preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the 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. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.

C. Apply insulation to fittings and elbows as follows:

1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions and cover with insulating cement trowelled smooth.
2. When premolded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with tape and cover with insulating cement trowelled smooth.
3. Cover fittings with standard PVC fitting covers.

D. Apply insulation to valves and specialties as follows:

1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When premolded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.

3.5 CELLULAR GLASS INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Secure each layer of insulation to pipe with wire, tape, or bands without deforming insulation materials.
2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic.
3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure

tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

5. All exposed ends for mineral fiber insulation shall be neatly trimmed and beveled. All exposed insulation material shall be covered with mastic.

3.6 FIELD APPLIED JACKET APPLICATION

- A. Apply aluminum metal jacket for all exterior above ground chilled water piping, with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal joints with weatherproof sealant recommended by insulation cover manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
- B. Apply glass cloth or PVC jacket, for piping that is exposed in all areas including mechanical rooms, directly over insulation with factory-applied jackets.
 1. Apply jacket smooth and tight to surface with 1-inch overlap at seams and joints.
 2. Embed glass cloth between two (2) 0.062-inch thick coats of jacket manufacturer=s recommended adhesive.
 3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.
- C. Provide PVC fitting covers for all exposed piping that is to be insulated. For Victaulic piping, provide PVC fitting covers for all fittings and couplings.

3.7 PIPING SYSTEM APPLICATIONS

- A. Materials and thicknesses for systems listed below are specified in schedules within this section.
- B. Insulate the following piping systems:
 1. Insulate dual temperature water supply and return piping with glass fiber insulation
 2. Insulate condensate drain piping with glass fiber insulation.
- C. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
 1. Flexible connectors and Vibration-control devices.
 2. Vibration-control devices.
 3. Fire-suppression piping.
 4. Below-grade piping, unless otherwise indicated.
 5. Chrome-plated pipes and fittings, unless potential for personnel injury.
 6. Hot water air chambers, unions, strainers, check valves, plug valves, and flow regulators.

D. MINIMUM INSULATION THICKNESS FOR PIPE SIZES

Hot water piping insulation shall be 1-1/2" thick and Chilled Water piping insulation shall be 1-1/2" thick on piping 4" and smaller and 2" thick on piping 5" and larger.

PIPING SYSTEM TYPES	FLUID TEMPERATURE RANGES (DEG. F)	LESS THAN 1" (INCHES)	1" TO 1-1/4" (INCHES)	1" TO 3" (INCHES)	1-1/2" TO LARGER (INCHES)	4" AND (INCHES)
Dual Temperature Water	38°-60°F	1.5	1.5	1.5	2.0	
Condensate Drain	40°-105°F	0.5	0.5	1.0	1.0	

NOTE: The minimum listed thickness is based on a minimum R value of 4.6. Thickness to vary if the insulation R value is different than 4.6. In addition, the minimum thickness is to be increased as required to meet ASHRAE 90.1.

E. Insulation at fire walls: All insulated piping penetrating walls with a fire resistive rating shall be insulated with molded foam glass; "ASJ-SSL" covering with a dual purpose fireproof, kraft aluminum foil, laminated white jacket. Insulation to be of same thickness as adjoining insulation.

F. PIPE INSULATING SUPPORT

1. On insulated piping with pipe supports around outside of covering provide galvanized steel formed bearing plates. Plates to be lined with length of foam glass insulation.
 - a. 8" and smaller pipe: 12" long, 12 gauge plate
 - b. 10" and larger pipe: 24" long, 10 gauge plate

3.8 FIELD QUALITY CONTROL

A. Insulation applications will be considered defective if sample inspection reveals noncompliance with requirements. Remove defective Work and replace with new materials according to these Specifications.

END OF SECTION 230700

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SECTION 230702 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes semi-rigid and flexible duct and plenum insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

1.2 SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness and jackets (both factory and field applied, if any), for each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details for the following:
 - 1. Removable insulation sections at access panels.
 - 2. Application of field-applied jackets.
 - 3. Applications at linkages for control devices.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread rating of 25 or less and smoke-developed rating of 50 or less.
- C. ASHRAE Standards: Comply with performance efficiencies prescribed for ASHRAE 90.1, "Energy Efficient Design for New Buildings, Except Low Rise Residential Buildings" for duct insulation.
- D. No damaged or water soaked insulation shall be used.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade and maximum use temperature.

1.5 COORDINATION

- A. Coordinate clearance requirements with duct Installer for insulation application.

1.6 SCHEDULING

- A. Schedule insulation application after testing duct systems. Insulation application may begin on segments of ducts that have satisfactory test results.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the manufacturers specified:
1. Mineral-Fiber Insulation:
 - a. CertainTeed Manson.
 - b. Knauf FiberGlass GmbH.
 - c. Owens-Corning Fiberglas Corp.
 - d. Schuller International, Inc.
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
 2. Isocyanurate Insulation
 - a. Polyisocyanurate Duct Insulation:
 - 1) Insulation shall be molded Trymer 2000XP polyisocyanurate insulating “ASJ-SSL” covering including a dual purpose fireproof, kraft aluminum foil laminated (white) jacket.
 - 2) Adjoining sections shall be butted firmly together and the longitudinal lap of the vapor barrier jacket shall be sealed with the white flamesafe vapor barrier strips applied with flamesafe lap cement. Bands shall be applied over edges of joint seal strips and at center of each section of insulation.
 - 3) Fully adhered white EPDM sheet.

2.2 INSULATION MATERIALS

- A. Mineral-Fiber Board Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB, without facing and with all-service jacket manufactured from aluminum foil, skim kraft, vapor seal.
- B. Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, without facing and with all-service jacket manufactured from aluminum foil, skim kraft, vapor seal.
- C. Glass Fiber Duct Liner
1. Insulation ASTM C553; flexible noncombustible with erosion resistant and mold resistant coating.
 - a. ‘K’ value: ASTM C518 and C177, 024 at 75 degrees F.

- b. Maximum Service Temperature: 250 degrees F.
 - c. Maximum Moisture Absorption: 0.5 percent per volume.
 - d. Density: 3.0 11/cu ft.
- D. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
- E. 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 FIELD-APPLIED JACKETS

- A. General: ASTM C 921, Type 1, unless otherwise indicated.
- B. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.
- C. Glass Cloth Covering: Self-adhesive, mastic impregnated, rewettable cloth.
 - 1. Thickness: 0.028 inches
 - 2. Maximum Service Temperature: 450 degrees F.
 - 3. Density: 14.3 pz/sq yd
 - 4. Surface Burning Characteristic: 25/50 per ASTM E84
- D. Aluminum Jacket: Comply with ASTM B 209, 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. 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. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.4 ACCESSORIES AND ATTACHMENTS

- A. Wire: 0.062-inch, soft-annealed, galvanized steel.

- B. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.
 - 1. Adhesive: Recommended by the anchor pin manufacturer as appropriate for surface temperatures of ducts and plenums; and to achieve a holding capacity of 100 lb for direct pull perpendicular to the adhered surface.
- C. Self-Adhesive Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.
- D. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 14.3 oz./sq. yd.
 - 1. Tape Width: 4 inches
- E. Aluminum Jacket strapping and seals: All jacketing shall be secured on not greater than 18 inch centers with aluminum straps not less than 0.20 inch thickness. All jacketing shall have 0.75 inch wide aluminum wing seals not less than 0.32 inch thickness.

2.5 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets and substrates.

2.6 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 °F.
 - 4. Color: Aluminum.
 - 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”.

2.7 TAPES

- A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 - 1. Width: 3 inched (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.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.
- B. Refer to schedules at the end of this Section for materials, forms, jackets and thicknesses required for each duct system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply multiple layers of insulation with longitudinal and end seams staggered.
- E. Keep insulation materials dry during application and finishing.
- F. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- G. Apply insulation with the least number of joints practical.
- H. Apply insulation over fittings and specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
- I. Apply insulation with integral jackets as follows:
 1. Pull jacket tight and smooth.
 2. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
- J. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.
- K. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.

- L. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations.
- M. Provide weld pins located a maximum of 18 inches on center for all insulation serving ductwork that has a width or height dimension that exceeds 20 inches.
- N. Floor Penetrations: Terminate insulation at underside of floor assembly and at floor support at top of floor.
 - 1. For insulation indicated to have vapor retarders, taper termination and seal insulation ends with vapor-retarder mastic.

3.4 MINERAL FIBER INSULATION APPLICATION

- A. Blanket or Board Applications for Ducts and Plenums: Secure blanket insulation with adhesive, anchor pins and speed washers.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per square foot 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 anchor pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints and locate 16 inches on center.
 - b. On duct sides with dimensions larger than 18 inches. Space 16 inches on center each way and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
 - c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over-compress insulation during installation.
 - 4. Impale insulation over anchors and attach speed washers.
 - 5. 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.
 - 6. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch on center and cover with pressure-sensitive tape having same facing as insulation.
 - 7. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Apply insulation on round duct elbows with individually mitered gores cut to fit the elbow.
 - 8. Insulate duct stiffeners, hangers and flanges that protrude beyond the insulation surface with 6-inch wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger and flange with anchor pins spaced 6 inches on center.

3.5 FIELD APPLIED JACKET APPLICATION

- A. Apply glass cloth jacket directly over insulation with factory applied jackets for all exposed insulation for all exposed insulation in finished, occupied rooms and mechanical rooms.
 - 1. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 - 2. Embed glass cloth between two (2) 0.062-inch thick coats of jacket manufacturer=s recommended adhesive.
 - 3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

3.6 DUCT SYSTEM APPLICATIONS

- A. Materials and thicknesses for systems listed below are specified in schedules at the end of this Section.
- B. Insulate the following plenums and duct systems:
 - 1. Indoor concealed supply and outside air ductwork.
 - 2. Indoor exposed supply and outside air ductwork.
 - 3. Exterior exhaust and outside air ductwork.
 - 4. Insulate indoor return air ductwork and plenums only where specifically indicated on the design drawings.
- C. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials and equipment:
 - 1. Metal ducts with duct liner.
 - 2. Manufactured double wall, insulated duct systems.
 - 3. Factory-insulated flexible ducts.
 - 4. Factory-insulated plenums, casings, terminal boxes, filter boxes and sections.
 - 5. Flexible connectors.
 - 6. Vibration-control devices.
 - 7. Testing agency labels and stamps.
 - 8. Nameplates and data plates.
 - 9. Access panels and doors in air-distribution systems.

3.7 INDOOR DUCT APPLICATION SCHEDULE

- A. Service: Round supply and outdoor air ducts; concealed.
 - 1. Material: Mineral-fiber blanket.
 - 2. Thickness: 1-1/2 inches.
 - 3. Minimum R value: 3.5.
 - 4. Number of Layers: One.

- B. Service: Rectangular supply and outdoor air ducts; concealed.
 - 1. Material: Mineral-fiber blanket.
 - 2. Thickness: 1-1/2 inches.
 - 3. Minimum R value: 3.5.
 - 4. Number of Layers: One.

- C. Service: Round supply and outdoor air ducts; exposed.
 - 1. Material: Mineral-fiber board.
 - 2. Thickness: 1-1/2 inches.
 - 3. Minimum R Value: 3.5.
 - 4. Number of Layers: One.

- D. Service: Rectangular supply and outdoor air ducts; exposed.
 - 1. Material: Mineral-fiber board.
 - 2. Thickness: 1-1/2 inches.
 - 3. Minimum R Value: 3.5.
 - 4. Number of Layers: One.

- E. Service: Rectangular transfer air ducts; concealed and rectangular return air ducts where specifically indicated on the drawings to be internally lined.
 - 1. Material: Fiberglass Duct Liner
 - 2. Thickness: 1 inch

- F. Service: Rectangular and round supply and return air ducts in spaces not tempered.
 - 1. Insulation Material: Mineral fiber blanket.
 - 2. Thickness: 2 inches.
 - 3. Minimum R Value: 8

- G. Thermal Insulation for all Ductwork on the Roof (Exterior of Ductwork)
 - 1. Duct Insulation:
 - a. Polyisocyanurate Duct Insulation.

3.8 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".

END OF SECTION 230702

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SECTION 230800 – COMMISSIONING OF HVAC

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.
- B. Refer to Section 019113 "Commissioning" for all specific requirements required associated with the commissioning process that will be required as part of this work. As part of this project, participation in the commissioning process as described in Section 01 91 13 shall be required.

1.2 SUMMARY

- A. Section includes commissioning process requirements for HVAC systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 DEFINITIONS

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.
- D. DDC: Direct Digital Controls.
- E. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 ALLOWANCES

- A. Labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing are covered by the "Schedule of Allowances" Article in Division 01 Section "Allowances."

1.5 UNIT PRICES

- A. Commissioning testing allowance may be adjusted up or down by the "List of Unit Prices" Article in Division 01 Section "Unit Prices" when actual man-hours are computed at the end of commissioning testing.

1.6 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase HVAC and Integrated Automation coordination meetings.
- C. Attend testing, adjusting, and balancing review and coordination meetings.

- D. Participate in HVAC systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- E. Provide information requested by the CxA for final commissioning documentation.
- F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.7 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning testing.
- C. Verify testing, adjusting, and balancing of Work are complete.
- D. Provide test data, inspection reports, and certificates in Systems Manual.

1.8 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC systems, assemblies, equipment, and components to be verified and tested.
 - 4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
 - 5. Certificate of readiness certifying that HVAC systems, subsystems, equipment, and associated controls are ready for testing.
 - 6. Test and inspection reports and certificates.
 - 7. Corrective action documents.
 - 8. Verification of testing, adjusting, and balancing reports.

1.9 SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, prestart, and startup activities.

1.10 COMMISSIONING AUTHORITY

- A. Motz Engineering acting in conjunction with the Owner's Maintenance Personnel will take the role of the Commissioning Authority for this project. The Commissioning Authority will respond to all issues directly to the Owner and shall have the authority to grant final acceptance of each system commissioned.

1.11 COMMISSIONING PLAN

- A. This section and sections in other Divisions shall outline the work required for the project, consistent with the Commissioning Plan. Any discrepancies between the Commissioning Plan and the Project Manual sections shall be brought to the attention of the Commissioning Agent for clarification.

1.12 COORDINATION

- A. The General Contractor and appropriate Subcontractors shall be responsible for cooperating and coordinating their work during the installation and commissioning process. Refer to the specific requirements and other sections for required work associated with coordination of installation work and preparation of Coordination Construction Drawings by the contractors.
- B. The Commissioning Authority will participate in the coordination of installation work as necessary to insure the installation of system components meet the Owner's project requirements and will provide a facility that has appropriate access and means for future maintenance and service by Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

- A. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that HVAC instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING VERIFICATION

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC systems at the direction of the CxA.
 - 1. The CxA will notify testing and balancing Subcontractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.

2. The testing and balancing Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of HVAC testing shall include entire HVAC installation.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. Tests will be performed using design conditions whenever possible.
- E. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- F. The CxA may direct that set points be altered when simulating conditions is not practical.
- G. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- H. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- I. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. The following systems shall be commissioned:
 1. HVAC systems including:
 - a. Direct digital automatic temperature control system.
 - b. Air distribution systems.
 - c. Exhaust systems.
 - d. Unitary equipment.

END OF SECTION 230800

SECTION 231123 – NATURAL GAS PIPING

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. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Valves.

1.3 DESCRIPTION OF SYSTEM

- A. Extend new gas piping to new boilers.

1.4 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.5 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
 - 2. Service Regulators: 65 psig minimum unless otherwise indicated.
 - 3. Minimum Operating Pressure of Service Meter: 5 psig.

1.6 SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Piping specialties.
 - 2. Valves. Include pressure rating, capacity, settings, etc.

3. Dielectric fittings.
 4. Mechanical sleeve seals.
 5. Escutcheons.
- B. Shop Drawings: For 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, and attachments of the same to building structure. Detail location of anchors, alignment guides, etc.
1. Shop Drawing Scale: 1/4 inch per foot.
 2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.
- C. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- D. Welding certificates.
- E. Field quality-control reports.
- F. Operation and Maintenance Data: For pressure regulators and service meters to include in emergency, operation, and maintenance manuals.

1.7 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.
- C. 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.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.9 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
 - 5. Mechanical Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Dresser Piping Specialties; Division of Dresser, Inc.
 - 2) Smith-Blair, Inc.
 - b. Steel flanges and tube with epoxy finish.
 - c. Buna-nitrile seals.
 - d. Stainless-steel bolts, washers, and nuts.
 - e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

2.2 PIPING VALVES & SPECIALTIES

- A. Furnish and install all valves and specialties where shown or required for the proper operation of the system.
 - 1. At each piece of equipment: Provide a lubricated plug cock.
 - 2. At each low point in piping: A 6" long drip pocket consisting of pipe the same size as the riser, capped at the bottom.
 - 3. Valves shall always be placed in accessible positions for operation and repairs.

2.3 JOINING MATERIALS

- A. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 DIELECTRIC FITTINGS

- A. Refer to Section 23 05 17.

2.5 SLEEVES

- A. Refer to Section 23 05 17.

2.6 MECHANICAL SLEEVE SEALS

- A. Refer to Section 23 05 17.

2.7 ESCUTCHEONS

- A. Refer to Section 23 05 17.

2.8 GROUT

- A. Refer to Section 23 05 17.

2.9 LABELING AND IDENTIFYING

- A. Refer to Section 23 05 53.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 requirements for prevention of accidental ignition.

3.3 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- 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. Locate valves for easy access.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Verify final equipment locations for roughing-in.
- J. 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.
- K. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- L. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- M. Connect branch piping from top or side of horizontal piping.
- N. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- O. Do not use natural-gas piping as grounding electrode.
- P. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

3.4 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas connection.

3.5 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:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
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.

E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

3.7 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 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.

3.8 LABELING AND IDENTIFYING

- A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 1. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 231123

SECTION 232111 - PIPING MATERIALS

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 a summary of all Piping Materials related work:
- B. Related Sections:
 - 1. 232113 – HYDRONIC PIPING

1.3 DUAL TEMPERATURE WATER PIPING

- A. 2-1/2" and Larger.
 - 1. Pipe: Standard, A-53 black steel.
 - 2. Fittings: Standard, butt-weld.
- B. 2" and Smaller.
 - 1. Pipe: Type "L" copper tubing, hard temper.
 - 2. Fittings: Solder end, cast red brass or wrought copper.

1.4 GAS PIPING

- A. All Piping in Building.
 - 1. Pipe: Standard, A-53 black steel.
 - 2. Fittings: Standard, butt-weld or socket weld.

1.5 GAS VENTS

- A. 1-1/4" and Larger.
 - 1. Pipe: Standard, A-53 black steel.
 - 2. Fittings: Threaded 150# black malleable iron.
- B. 1" and Smaller.
 - 1. Pipe: Type "L" copper tubing, hard temper.
 - 2. Fittings: Solder end, cast red brass or wrought copper.

1.6 DRAIN PIPING

A. Copper Piping.

1. Pipe: Type "L" copper tubing, hard temper.
2. Fittings: Solder end, cast red brass or wrought copper.

PART 2 – PRODUCTS – (NOT USED)

PART 3 – EXECUTION – (NOT USED)

END OF SECTION 232111

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SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes piping, special-duty valves, and hydronic specialties for air vent piping, blowdown drain lines and condensate drain piping.

1.2 SUBMITTALS

- A. Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
 - 1. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable manufacturer's style or series designation.
- B. Welding Certificates: Copies of certificates for welding procedures and personnel.
- C. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Failed test results and corrective action taken to achieve requirements.
- D. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals specified in Division 1.
- E. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.3 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
- C. To assure uniformity and compatibility of piping products in grooved end piping systems, all groove products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied by the same manufacturer.
- D. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in use of grooving tools, application of groove and installation of grooved joint products. The manufacturer's representative shall periodically visit the jobsite and review the installation. The Contractor shall remove and replace all joints deemed to be improperly installed.

1.4 COORDINATION

- A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate pipe sleeve installations for foundation wall penetrations.

- C. Coordinate pipe fitting pressure classes with products specified in related Sections.
- D. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3 Sections.
- E. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping for fire wall and floor assemblies.

1.5 EXTRA MATERIALS

- A. Water Treatment Chemicals: Furnish sufficient chemicals for initial system startup and for preventive maintenance for one (1) year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Pressure-Reducing Valves:
 - a. Amtrol, Inc.
 - b. Conbraco Industries, Inc.
 - c. ITT Bell & Gossett; ITT Fluid Technology Corp.
 - d. Spence Engineering Company, Inc.
 - e. Watts Industries, Inc.; Watts Regulators.

2.2 PIPING MATERIALS

- A. General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.3 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. DWV Copper Tubing: ASTM B 306, Type DWV.
- C. Wrought-Copper Fittings: ASME B16.22. For hot and chilled water piping, Pro-Press fittings rated for 200 PSI operating pressure, 600 PSI test pressure and with 50 year warranty shall be permitted as an acceptable alternative for pipe sizes up to 4 inch system to be per ASTM B16. 18 or ASTM B16.22 with EPDM O-Rings.
- D. Wrought-Copper Unions: ASME B16.22.
- E. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.
- F. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver).

2.4 VALVES

- A. Gate, check, ball, and butterfly and calibrated balancing valves are specified in Division 23 Section 230523.

PART 3 – EXECUTION

3.1 PIPING APPLICATIONS

- A. Condensate Drain Lines: Type L drawn-temper copper tubing with soldered joints.

3.2 VALVE APPLICATIONS

- A. General Duty Valve Applications: Unless otherwise indicated, use the following valve types:
 - 1. Shutoff Duty: Ball and butterfly valves, (as indicated on the drawings).
- B. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.

3.3 PIPING INSTALLATIONS

- A. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- B. Install drains, consisting of a tee fitting, NPS 3/4 ball drain valve, at low points in piping system mains and elsewhere as required for system drainage.
- C. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- D. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- E. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.
- F. Anchor piping for proper direction of expansion and contraction.

3.4 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports." Comply with requirements below for maximum spacing of supports.
- B. Install the following pipe attachments:
 - 1 Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 3. Spring hangers to support vertical runs.
 - 4. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- C. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4": Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. NPS 1": Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. NPS 1-1/2" to 2": Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 4. NPS 2-1/2": Maximum span, 9 feet; minimum rod size, 3/8 inch.
- D. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors

3.5 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
1. Leave joints, including welds, un-insulated 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 system with clean water. Clean strainers.
 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 trapped air. Use drains installed at low points for complete draining of liquid.
 3. Check expansion tanks to determine that they are not air bound and that system is full of water.
 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design 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 either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of 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. Final test shall hold pressure for eight (8) hours.
 6. Prepare written report of testing.

3.6 CLEANING

- A. Flush hydronic piping systems with clean water. Remove and clean or replace strainer screens. After cleaning and flushing hydronic piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers.

END OF SECTION 232113

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SECTION 232116 – DUAL TEMPERATURE WATER SYSTEM

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 DESCRIPTION OF SYSTEM

- A. New dual temperature water piping to accommodate this project.

1.3 DUAL TEMPERATURE WATER SYSTEM EQUIPMENT

- A. New Coils in Fan Coil Units. Refer to Section 238219.

1.4 CONNECTIONS

- A. Furnish and install the following valves and specialties:
 - 1. At water coils at each new Fan Coil Unit:
 - a. In return connection from water coil: A butterfly or ball valve and 3/4" drain valve with hose fitting capped.
 - b. In return connection from water coil: An automatic two-way water valve, as hereinafter specified.
 - c. In inlet to each coil: A ball valve, strainer, 3/4" drain valve, and a flange.
 - d. In outlet of each coil: A calibrated balancing valve, air vent, a ball valve, and a flange.
 - 2. In branch piping, where shown, and at high points of the system: One 1/8" manual air vent cock.
 - 3. In the mains at high points of the system: One Anderson, Crane, Fischer, Hoffman, or equal, 1/2" automatic air vent trap with cast iron body and bronze float and valve mechanism, and with discharge piped to floor drain except at fan coil units air vent discharge shall be piped to fan coil unit drain.
 - 4. Where shown, and at all low points of piping: A 3/4" drain valve with hose fitting capped.

1.5 INSTRUMENTS

- A. Furnish and install the following instruments:
 - 1. In the piping, 1/2" pressure-temperature test plugs at the following locations as specified in Paragraph 23 05 19:
 - a. At inlet of coil.
 - b. At outlet of coil.
 - c. At inlet and outlet of strainer at coil.
 - d. At inlet and outlet of new temperature control valve at new coil.

1.6 VALVES AND SPECIALTIES

- A. Furnish and install valves and specialties as indicated on the drawings.
- B. In branch piping, where shown, and at high points of the system: One (1) 1/8" manual air vent cock.
- C. In the mains at high points of the system: One (1) 2" automatic air vent with discharge piped to floor drain. Refer to Section 23 05 19.
- D. Where shown, and at all low points of piping: A 3/4" drain valve with hose fitting capped.

PART 2 – PRODUCTS – (NOT USED)

PART 3 – EXECUTION – (NOT USED)

END OF SECTION 232116

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SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2 to plus 4 inch w.g. Metal ducts are to include the following:
 - 1. Rectangular ducts and fittings.
 - 2. Single-wall, round spiral-seam ducts and formed fittings.
 - 3. Duct liner.

1.2 SYSTEM DESCRIPTION

- A. Duct system design, as indicated, has been used to select size and type of air moving and distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by the Engineer. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.3 SUBMITTALS

- A. See Section 230000 General HVAC for requirements for coordination drawings.
- B. Shop Drawings: The Sheet Metal Contractor shall prepare ductwork drawings, at a minimum scale of 1/4" = 1'-0", in a BIM Modeling Software (Revit or Navis Works). Submit an electronic copy of ductwork drawings for review and approval by the Architect/Engineer before coordination drawings are submitted for coordination. Drawings may be submitted to the Architect/Engineer in stages if required to expedite work. Do not proceed with fabrication of ductwork until submitted drawings are approved by the Architect/Engineer

1.3 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," for hangers and supports and AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. NFPA Compliance:
 - 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
 - 2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

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 one (1) of the manufacturers specified.

2.2 SHEET METAL MATERIALS

- A. Comply with the most current version of 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: Lock-forming quality; complying with ASTM A 653 and having G60 (Z180) coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. Carbon-Steel Sheets: ASTM A 366 cold-rolled sheets; commercial quality; with oiled, matte finish for exposed ducts.
- D. Stainless Steel: ASTM A 480, Type 304, and having a No. 2D finish for concealed ducts and mill for exposed ducts.
- E. Aluminum Sheets: ASTM B 209, alloy 3003, tempered H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- F. Exposed ductwork shall be suitable for painting (paint grip) in field by General Contractor.
- G. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
- H. Tie Rods: Galvanized steel, 1/4 inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 SEALANT MATERIALS

- A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.
- B. Joint and Seam Tape: 2 inches wide; glass-fiber-reinforced fabric.
- C. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
- D. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.
- E. Solvent-Based Joint and Seam Sealant: One-part, non-sag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.
- F. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
- G. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.4 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4

inches thick.

2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
1. Strap and Rod Sizes: Comply with the most current version of SMACNA's "HVAC Duct Construction Standards-Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
 2. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36.
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
 3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

2.5 RECTANGULAR DUCT FABRICATION

- A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to the most current version of SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
 2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
1. Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Nexus Inc.
 - c. Ward Industries, Inc.

- C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.
 - 1. Duct Size: Maximum 30 inches wide and up to 2-inch wg pressure class.
 - 2. Longitudinal Seams: Pittsburgh lock sealed with non-curing polymer sealant.
- D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of non-braced panel area unless ducts are lined.

2.6 ROUND DUCT AND FITTING FABRICATION

- A. Round, Spiral Lock Seam Ducts: Fabricate supply ducts of galvanized steel according to the most current version of SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
 - 1. Manufacturers:
 - a. Lindab
 - b. McGill AirFlow Corporation.
 - c. SEMCO Incorporated.
- B. Duct Joints:
 - 1. Minus 2 inches wg to plus 2 inches wg pressure class
 - a. Ducts up to 20 inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
 - b. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two (2) internal flanges with sealant and one (1) external closure band with gasket.
 - c. Joints shall be made with pop rivets or sheet metal screws and sealed.
 - 2. Less than minus 2 inches wg or more than plus 2 inches wg pressure class
 - a. All fitting ends shall come factory equipped with a double lipped, U-profile, EPDM rubber gasket. Gasket shall be manufactured to gauge and flexibility so as to insure that system will meet all of the performance criteria set forth in the manufacturer's literature. Gasket shall be classified by Underwriter's Laboratories to conform to ASTM E84-91a and NFPA 90A flame spread and smoke developed ratings of 25/50.
 - b. All fitting ends shall be calibrated to manufacturer's published dimensional tolerance standard and associated spiral duct.
 - c. All fitting ends from 3" to 24" Dia. shall have rolled over edges for added strength and rigidity.
 - d. All elbows from 3" to 12" Dia. shall be 2-piece die stamped and continuously stitch welded. All elbows 14" Dia. and larger shall be standing seam gorelock construction and internally sealed.
 - e. The radius of all 90° and 45° elbows shall be 1.5 times the elbow diameter.
 - f. All fittings that are of either spot welded or button punched construction shall be internally sealed.

- g. Fittings shall be connected with self tapping sheet metal screws or pressure proof pop rivets in quantity and procedure per manufacturer=s recommendations.
- C. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "1985 HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.
- D. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.
- E. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:
 - 1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
 - 2. Die-Formed Elbows for Sizes through 12 Inches in Diameter with 2-piece welded construction, 24 ga.
 - 3. Round Elbows Larger Than 14 Inches in Diameter: Fabricate gored elbows 22 ga. for 16 inches through 26 inches, 20 ga. for 28 inches and above.
- F. All tees and crosses shall be conical fittings.
- G. Round connections to rectangular ducts shall be made with bellmouth fittings.
- H. All connections to round ductwork shall be made with full body fittings. Side taps and saddles are not acceptable.

2.7 INSULATED CASING

- A. Construct casing for the outdoor air plenums. Casing shall be built per field conditions. Casing shall be self-supporting, prefabricated steel panels, 2" thick, with 4-1/4 lb. density insulation, encased in inner face of minimum 20 gauge, galvanized steel sheet and stainless steel outer sheet; connection between inner and outer skins shall be thermally broken.
- B. Exterior skin to be stainless steel where indicated on drawings.

2.8 STAINLESS STEEL DUCTS

- A. Where indicated on the drawings, within 18" of outdoor air louvers, ducts shall be constructed of 304-2B stainless steel with mill finish and shall conform to the following schedule:

<u>Width in Inches</u>	<u>U. S. Gauge</u>
Up to 30"	No. 26

- B. Joints: All joints and seams shall be continuously soldered with stainless steel solder and made watertight. Longitudinal seams shall be on top side of horizontal ducts.

PART 3 – EXECUTION

3.1 DUCT APPLICATIONS

- A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:
 - 1. Supply Ducts (from air handling units to VAV terminal units), (Positive Pressure): 4 inch w.g. pressure class.
 - 2. Supply Ducts: (from terminal units to air devices), (Positive Pressure): 2-inch w.g. pressure class.
 - 3. Return Ducts: (from air devices to air handling units) (Negative Pressure): 2-inch w.g. pressure class.
 - 4. Exhaust Ducts, (Negative Pressure): 2-inch w.g. pressure class.
 - 6. Outside Air Ducts, (Positive and Negative Pressure): 2-inch pressure class.
 - 7. Combustion Air & Transfer Air (Positive Pressure): 2 inch pressure class.
- B. All ducts shall be of galvanized steel construction except for Type 2 exhaust hoods and clothes dryer exhaust ducts which shall be of aluminum construction and Type 1 exhaust hood ductwork which shall be welded 304 stainless steel. Type 1 and Type 2 exhaust hood exhaust ductwork shall comply with the requirements of the Ohio Mechanical Code.

3.2 DUCT INSTALLATION

- A. Construct and install ducts according to the most current version of SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
- B. Install round ducts in lengths not less than 10 feet unless interrupted by fittings.
- C. Install ducts with fewest possible joints.
- D. Install fabricated fittings for changes in directions, size, and shape and for connections. Fittings indicated on drawings are diagrammatic and are for information purposes only.
- E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of three (3) screws in each coupling.
- F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- 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, plus allowance for insulation thickness.
- I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- J. Coordinate layout with suspended ceiling, fire-dampers, lighting layouts, and similar finished work.
- K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws. Longitudinal joints shall be on the top side of horizontal ducts.

- L. Electrical Equipment Spaces: Route ducts to avoid passing through electrical equipment spaces and enclosures.
- M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.
- N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant.
- O. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction." All ductwork is to be maintained at the SMACNA Intermediate Cleanliness level.
- P. This Contractor shall paint interiors of metal ducts, that do not have duct liner, for 24 inches upstream and downstream of duct mounted registers and grilles. Apply one (1) coat of flat, black, latex finish coat over a compatible galvanized-steel primer.
- Q. Duct dimensions on drawings are inside clear dimensions.

3.3 SEAM AND JOINT SEALING

- A. Seal all duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.
- B. Seal ducts before external insulation is applied.

3.4 HANGING AND SUPPORTING

- A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
- B. Support vertical ducts at maximum intervals of 6 feet and at each floor.
- C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- D. Install concrete inserts before placing concrete.
- E. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors.
- 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 existing 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 Division 23 Section "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.
 4. Coils and related components.
 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 6. Supply-air ducts, dampers, actuators, and turning vanes.
 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 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:
 1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test the entire system at the maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven (7) days' advance notice for testing.
 3. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for round ducts, Leakage Class 12 for rectangular ducts in pressure classes lower than and equal to 2 inch w.g. (both positive and negative pressures) and leakage class 6 for pressure classes above 2 inch w.g.
 4. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

END OF SECTION 233113

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SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Backdraft dampers.
 - 2. Volume dampers.
 - 3. Fire dampers.
 - 4. Smoke dampers.
 - 5. Combination fire and smoke dampers.
 - 6. Motorized Control Dampers.
 - 7. Turning vanes.
 - 8. Remote damper operators.
 - 9. Duct-mounting access doors.
 - 10. Flexible connectors.
 - 11. Flexible ducts.
 - 12. Duct accessory hardware.
- B. The motorized automatic control dampers are supplied by the HVAC Contractor. The HVAC contractor shall install the motorized automatic control dampers. TCC shall provide operators and linkage.

1.2 SUBMITTALS

- A. Product Data: For the following:
 - 1. Backdraft dampers.
 - 2. Volume dampers.
 - 3. Fire dampers.
 - 4. Smoke dampers.
 - 5. Combination fire and smoke dampers.
 - 6. Motorized Control Dampers.
 - 7. Turning vanes.
 - 8. Remote damper operators.
 - 9. Duct-mounting access doors.

10. Flexible connectors.
11. Flexible ducts.
12. Duct accessory hardware.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. In other part 2 articles where subparagraphs titles below introduce lists, the following requirements apply for product selection.
 1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the manufacturers specified.

2.2 SHEET METAL MATERIALS

- A. Comply with the most current version of SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653 and having G60 (Z180) coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. Stainless Steel: ASTM A 480.
- D. Aluminum Sheets: ASTM B 209, alloy 3003, tempered 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 minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT DAMPERS

- A. Manufacturers:
 1. Air Balance, Inc.
 2. American Warming and Ventilating.
 3. Lindab (medium velocity basis of design)
 4. Greenheck.
 5. Prefco Products, Inc.
 6. Ruskin Company. (low velocity basis of design)
- B. Description: Multiple-blade, parallel action gravity balanced, with center-pivoted blades of maximum 6-inch

width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.

- C. Frame: 0.090 extruded aluminum, with mitered corners and mounting flange.
- D. Blades: 0.025-inch-thick, roll-formed aluminum.
- E. Blade Seals: Vinyl.
- F. Blade Axles: Galvanized steel.
- G. Tie Bars and Brackets: Galvanized steel.
- H. Return Spring: Adjustable tension.

2.4 VOLUME DAMPERS

- A. Manufacturers:
 - 1. Air Balance, Inc.
 - 2. American Warming and Ventilating
 - 3. Lindab (Medium velocity Basis of Design)
 - 3. McGill AirFlow Corporation
 - 4. Metalaire, Inc.
 - 5. Ruskin Company (Low velocity Basis of Design)
- B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include dial type quadrant handle locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class. Provide stand-off assembly for all balancing dampers that are installed in insulated ducts.
- C. Standard Volume Dampers: Single-blade up to 6" blade width and opposed multi-blade on 8" and larger blade width, standard leakage rating, and suitable for horizontal or vertical applications.
 - 1. Steel Frames: 22 gauge, hat-shaped, galvanized sheet steel channels, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
 - 2. Roll-Formed Steel Blades: 22 gauge galvanized sheet steel.
 - 3. Blade Axles: Galvanized steel.
 - 4. Bearings: Molded synthetic.
 - 5. Tie Bars and Brackets: Aluminum.
 - 6. Tie Bars and Brackets: Galvanized steel.
- D. Low velocity rectangular: Ruskin Model MD25
- E. Low velocity round: Ruskin Model MDRS25

- F. Medium velocity round: Lindab Model DRU

2.5 FIRE DAMPERS

- A. Manufacturers:
 - 1. Air Balance, Inc.
 - 2. Greenheck.
 - 3. Prefco Products, Inc.
 - 4. Ruskin Company.
- B. Fire dampers shall be labeled according to UL 555.
- C. Fire Rating: 1-1/2 hours.
- D. Frame: Curtain type with blades and frame outside airstream; fabricated with roll-formed, 0.034-inch thick galvanized steel; with mitered and interlocking corners. Rectangular: Style "C". Round: Style "CR".
- E. Mounting Sleeve: Factory or field-installed, galvanized sheet steel, mounted outside airstream.
 - 1. Minimum Thickness: 0.052 or 0.138 inch thick as indicated and of length to suit application.
 - 2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.
- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, 0.034-inch thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch thick, galvanized-steel blade connectors.
- H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- I. Fusible Links: Replaceable, 212 deg F.

2.6 SMOKE DAMPERS

- A. General Requirements: Label according to UL 555S by an NRTL.
- B. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with interlocking, gusseted corners and mounting flange.
- C. Blades: Roll-formed, horizontal, interlocking, 0.034-inch-thick, galvanized sheet steel.
- D. Leakage: Class I.
- E. Rated pressure and velocity to exceed design airflow conditions.
- F. Mounting Sleeve: Factory-installed, 0.039-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone caulking.
- G. Damper Motors: two-position action.
- H. 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 and breakaway torque rating of 150 in. x lbf.
 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.
 6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
 7. Electrical Connection: 115 V, single phase, 60 Hz.
- I. Accessories:
1. Auxiliary switches for signaling.
 2. Test and reset switches, damper or remote mounted as required depending upon field conditions.

2.7 COMBINATION FIRE AND SMOKE DAMPERS

- A. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
- B. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
- C. Fire Rating: 1-1/2 and 3 hours as required at each location.
- D. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with interlocking, gusseted corners and mounting flange.
- E. Heat-Responsive Device: Resettable, 165 deg F rated, fusible links.
- F. Heat-Responsive Device: Electric resettable device and switch package, factory installed, rated.
- G. Blades: Roll-formed, horizontal, interlocking, 0.063-inch-thick, galvanized sheet steel.
- H. Leakage: Class I.
- I. Rated pressure and velocity to exceed design airflow conditions.
- J. Mounting Sleeve: Factory-installed, 0.039-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone caulking.
- K. Master control panel for use in dynamic smoke-management systems.
- L. Damper Motors: two-position action.
- M. 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 and breakaway torque rating of 150 in. x lbf.
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.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 115 V, single phase, 60 Hz.

N. Accessories:

1. Auxiliary switches for signaling.
2. Test and reset switches, damper or remote mounted as required, depending on field conditions.

2.8 MOTORIZED CONTROL DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. Greenheck.
4. Ruskin Company.

B. General Description: AMCA-rated, parallel or opposed blade design; minimum of 11 gauge thick, galvanized-steel frames with holes for duct mounting with maximum blade width of 8 inches.

1. Secure blades to 1/2 inch diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F .
3. Provide parallel or opposed-blade design with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4 inch wg when damper is being held by torque of 50 in. x lbf; when tested according to AMCA 500D.
4. Coordinate damper configuration with the Temperature Control Contractor including blade and rod as well as the operator mounting.
5. Refer to section 230900 for damper actuator specifications.

2.9 TURNING VANES

- A. Fabricate to comply with the most current version of SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
- B. Manufactured Turning Vanes: Fabricate 1-1/2 inch wide, airfoil-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.
 - 1. Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Duro Dyne Corp.
 - c. METALAIRE, Inc.

2.10 REMOTE DAMPER OPERATORS

- A. Description: Cable system designed for remote manual damper adjustment.
- B. Tubing: Copper.
- C. Cable: Stainless steel.
- D. Wall-Box Mounting: Recessed.
- E. Wall-Box Cover-Plate Material: Stainless steel.

2.11 DUCT-MOUNTING ACCESS DOORS

- A. General Description: Fabricate doors airtight and suitable for duct pressure class.
- B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include piano hinge and cam latches.
 - 1. Manufacturers:
 - a. American Warming and Ventilating.
 - b. CESCO Products.
 - c. Ductmate Industries, Inc.
 - d. Greenheck.
 - e. McGill AirFlow Corporation.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - 3. Provide number of hinges and locks as follows:
 - a. Less Than 12 Inches square: Secure with two (2) sash locks.
 - b. Up to 18 Inches Square: Two (2) sash locks.

- c. Up to 24 by 48 Inches: Secure with two (2) compression locks.
- C. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
- D. Insulation: 1-inch thick, fibrous-glass or polystyrene-foam board.

2.12 FLEXIBLE CONNECTORS

- A. Manufacturers:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Corp.
 - 3. Ventfabrics, Inc.
- B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3" to 6" wide attached to two strips of 2-3/4-inch wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Select metal compatible with ducts.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd.
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.
- 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..
 - 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 - 3. Service Temperature: Minus 50 to plus 250 deg F.

2.13 FLEXIBLE DUCTS

- A. Manufacturers:
 - 1. Flexmaster U.S.A., Inc.
 - 2. Hart & Cooley, Inc.
 - 3. McGill AirFlow Corporation.
- B. Non-insulated-Duct Connectors: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire.
 - 1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.

3. Temperature Range: Minus 20 to plus 175 deg F.
- C. Insulated-Duct Connectors: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor barrier film.
 1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 20 to plus 175 deg F.
- D. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

PART 3 – EXECUTION

3.1 APPLICATION AND INSTALLATION

- A. Install duct accessories according to applicable details in the most current version of 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. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers on exhaust fans or exhaust ducts where indicated.
- D. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two (2) duct widths from branch takeoff. Locking quadrants shall be easily accessible and shall be installed on the outside of the duct insulation.
- E. Install fire dampers, smoke dampers, and combination fire/smoke dampers with fusible links, according to manufacturer's UL-approved written instructions.
- F. Install all intake or exhaust air hoods on insulated roof curbs per all requirements of the hood manufacturer. The HVAC contractor is to provide flashing for all roof hoods.
- G. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:
 1. On both sides of duct coils.
 2. Downstream from volume dampers and equipment.
 3. Adjacent to fire dampers, providing access to reset or reinstall fusible links.
 4. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing. Duct mounted grilles will replace access doors for duct cleaning.
 5. On sides of ducts where adequate clearance is available.
- H. Install the following sizes for duct-mounting, rectangular access doors: Based on the following maximum duct dimensions:
 1. 9" and smaller: 6" x 8" door size.
 2. 10" to 12": 9" x 12" door size.

3. 13" to 16": 12" x 16" door size.
4. 18" and larger: 14" x 14" door size.
- I. Label access doors according to Division 23 Section "Mechanical Identification."
- J. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
- K. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- L. Connect diffusers to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place. See detail on drawings.
- M. Connect flexible ducts to metal ducts with draw bands.

3.2 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 233300

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SECTION 233713 - DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 REFERENCE

A. SCOPE OF WORK

1. Provide grilles, diffusers, air devices and appurtenances with size and capacities as shown on drawings.

1.2 SUBMITTALS

A. Product Data: For each product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish and mounting details; and performance data including throw and drop, static-pressure drop and noise ratings.
2. Diffuser, Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size and accessories furnished.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the manufacturers specified:

1. Price (Basis of Design)
2. Krueger
3. Titus
4. Anemostat

2.2 SQUARE PLAQUE FACED CEILING DIFFUSERS

- ##### A.
- Ceiling diffusers of sizes and mounting types designated by the plans and air device schedule. Diffusers shall consist of a precision formed back cone of one piece seamless construction which incorporates a round inlet collar of sufficient length for connecting rigid or flexible duct. An inner plaque assembly shall be incorporated that drops no more than 1/4" below the ceiling plane to assure proper air distribution performance. The inner plaque assembly shall be completely removable from the diffuser face to allow full access to any dampers or other ductwork components located near the diffuser neck. The diffuser is to include an integral opposed blade damper that is adjustable from the face of the air device. Finish shall be white powder coat.

2.3 SUPPLY REGISTERS

- ##### A.
- Supply registers of the sizes and mounting types indicated on the plans and outlet schedule. Registers shall be double deflection type with two sets of fully adjustable deflection blades spaced 3/4" on center. The front set of blades shall run parallel to the short or long dimension of the register as indicated in the air device schedule. The integral volume control damper shall be of the opposed blade type and shall be constructed of cold rolled steel. The damper shall be operable from the register face. The damper shall be coated steel. Registers are to be suitable for surface mounting or duct mounting as indicated on the drawings. Registers mounted in walls shall have steel plaster frames. Provide 1-1/4 " margin with countersunk screw mounting for drywall and masonry surfaces complete with mounting frame. Units in equipment rooms shall be a mill finish. All other registers shall have a white powder coat finish.

2.4 BAR TYPE EXHAUST AND RETURN REGISTER AND GRILLES

- A. Registers of the sizes and mounting types indicated on the plans and outlet schedule. Registers shall be 45 degree deflection fixed louver type with blades spaced 1/2" on center. The outlet shall have aluminum blades and support bars and frame. Blades shall run parallel to the long dimension of the register. The integral volume control damper shall be of the opposed blade type. The damper shall be operable from the register face. Registers mounted in ceilings shall have steel plaster frames. Provide 1-1/4 " margin with countersunk screw mounting for drywall and masonry surfaces complete with mounting frame. All registers shall have a white powder coat finish.

2.5 EGGCRATE GRILLES AND REGISTERS

- A. Exhaust registers and grilles of the sizes and mounting types indicated on the plans and air device schedule. Units shall be of aluminum construction, consisting of aluminum 1/2" x 1/2" x 1/2" eggcrate core and an extruded aluminum border. Units designated as registers shall be equipped with integral volume control damper of the opposed blade type and shall be constructed of heavy gauge cold rolled steel. The damper shall be operable from the register face. The damper shall be coated steel. Units in equipment rooms shall be a mill finish. All other units shall have white powder coat finish.

2.6 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install grilles, registers, diffusers and air devices 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 practicable. 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 grilles, registers, diffusers and air devices with airtight connections to ducts and to allow service and maintenance of dampers, air extractors and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust grilles, registers, diffusers and air devices to air patterns indicated, or as directed before starting air balancing.

END OF SECTION 237313

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SECTION 237414 – ENERGY RECOVERY VENTILATORS

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. This section includes units with integral heating and cooling for rooftop installation. Integral Energy Recovery device shall be a rotary air-to-air total enthalpy wheel. Integral heat source shall be Indirect Gas-Fired furnace. Integral cooling source shall be packaged DX. Airflow arrangement shall be Outdoor Air only. Each unit shall be constructed in a horizontal configuration and shall incorporate additional product requirements as listed in Section 2 of this specification.

1.3 SUBMITTALS

- A. Product Data: For each type or model include the following:
 1. Complete fan performance curves for both Supply Air and Exhaust Air, with system operating conditions indicated, as tested in an AMCA Certified Chamber.
 2. Sound performance data for both Supply Air and Exhaust Air, as tested in an AMCA Certified chamber.
 3. Motor ratings, electrical characteristics and motor and fan accessories.
 4. Performance ratings for all chilled water or DX coils.
 5. Dimensioned drawings for each type of installation, showing isometric and plan views, to include location of attached ductwork and service clearance requirements.
 6. Estimated gross weight of each installed unit.
 7. Installation, Operating and Maintenance manual (IOM) for each model.
 8. Microprocessor Controller (DDC) specifications to include available options and operating protocols. Include complete data on all factory-supplied input devices.
 9. AHRI Certified coil performance ratings with system operating conditions indicated. Ratings shall be in accordance with Standard 410.
 10. Energy wheel performance data for both summer and winter operation.

1.3. QUALITY ASSURANCE

- A. Source Limitations: Obtain unit with all appurtenant components or accessories from a single manufacturer.
- 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. ARI Compliance: Capacity ratings for air-to-air energy recovery equipment shall comply with ARI 1060, "Rating Air-to-Air Energy Recovery Equipment."

- D. ASHRAE Compliance:
- E. Applicable requirements in ASHRAE 62.1-2010, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- F. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."
- G. UL Compliance: Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators"; or UL 1815, "Nonducted Heat Recovery Ventilators."
- H. For the actual fabrication, installation, and testing of work under this section, use only thoroughly trained and experienced workers completely familiar with the items required and with the manufacturer's current recommended methods of installation.
- I. Product Options: Drawings must indicate size, profiles and dimensional requirements of unit and are to be based on the specific system indicated. Refer to Division 1 Section "Product Requirements".
- J. Certifications
 - 1. Blowers shall be AMCA Certified for air flow.
 - 2. Entire unit shall be ETL Certified per U.L. 1995 and bear an ETL sticker.
 - 3. Energy Wheel shall be AHRI Certified, per Standard 1060.
 - 4. Coils shall be Recognized Components for ANSI/UL 1995, CAN / CSA C22.2 No 236.05. DX and water coils shall be AHRI Certified per standard 410-2001.
 - 5. Indirect gas-fired furnace shall be ETL Certified as a component of the ERU. Indirect gas-fired furnace shall be an ETL Recognized Component of the ERU per ANSI Z83.8.

1.4. COORDINATION

- A. Coordinate size and location of all building penetrations required for installation of each unit and associated plumbing and electrical systems.
- B. Coordinate location of water system fittings to ensure correct positioning for connection to the water coil and condensate drain pipe.
- C. Coordinate sequencing of construction of associated plumbing, HVAC, electrical supply, roofing contractor.

1.5. 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. Filters: 1 set(s) of MERV 8 disposable Supply Air, Exhaust Air, and final filters for RTU-1 and 1 set of 30% efficient filters for ERV-1 for each unit.
 - 2. One set of energy wheel belts.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with specifications contained within this document, manufacturers offering products that may be incorporated into the work include, but are not limited to:
1. Greenheck Fan Corporation
 2. MicroMetl
 3. Cook
 4. Aaon

2.2. MANUFACTURED UNITS (RTU-1)

- A. Unit shall be fully assembled at the factory and consist of an insulated metal cabinet, exhaust air blower, evaporator coil, energy wheel, hot gas reheat coil, indirect gas-fired furnace, packaged DX system, phase and brownout protection, motorized dampers, motorized recirculating damper, curb assembly, filter assembly intake air, supply air blower assembly, exhaust/relief blower assembly, filter assembly for exhaust air, and an electrical control center. All specified components and internal accessories factory installed are tested and prepared for single-point high voltage connection except with electric post heat which has dual point power.

2.3. CABINET

- A. Materials: Formed, double wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
1. Outside casing: 22 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish. Pre-painted components as supplied by the factory shall have polyester urethane paint on 22 gauge G60 galvaneal steel. Components shall be painted with a polyester urethane powder coat.
 2. Internal assemblies: 22 gauge, galvanized (G90) steel except for motor supports which shall be minimum 14 gauge galvanized (G90) steel.
- B. Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
1. Materials: Rigid urethane foam
 - a. Thickness: 2 inch (50 mm)
 - b. Meets UL94HF-1 flame requirements.
 - c. Location and application: Full coverage of entire cabinet exterior to include walls, roof of unit, unit base, and doors.
 2. Materials: Fiberglass insulation. If insulation other than fiberglass is used, it must also meet the Fire Hazard Classification shown below.
 - a. Thickness: 2 inch (50 mm)

- b. Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.
 - c. Location and application: Divider panels between outdoor air and return air/exhaust air streams.
- C. Access panels / doors: Unit shall be equipped with insulated, hinged doors or removable access panels to provide easy access to all major components. Doors and access panels shall be fabricated of 22 gauge galvanized G90 steel.
- D. Supply Air blower assemblies: Blower assembly shall consist of an electric motor and direct-drive fans. Assembly shall be mounted on heavy gauge galvanized steel rails and further mounted on 1.125 inch thick neoprene vibration isolators. Blower motors shall be capable of continuous speed modulation and controlled by a VFD.
- E. Exhaust Air blower assemblies: Blower assembly shall consist of an electric motor and a direct-drive fan. Assembly shall be mounted on heavy gauge galvanized steel rails and further mounted on 1.125 inch thick neoprene vibration isolators. Blower motor shall be capable of continuous speed modulation and controlled by a VFD.
- F. Evaporator Coil: Evaporator coil shall be AHRI Certified and shall be (silver) soldered or brazed into the compressed refrigerant system. Coil shall be constructed of copper tubing, permanently bonded to aluminum fins and enclosed in a galvanized steel frame. If two compressors are used as components of the unit, then the evaporator coil shall be of "interlaced" configuration, permitting independent operation of either compressor without conflict with the other compressor.
- G. Control panel / connections: Units shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections. RTU shall be equipped with a Unit Disconnect Switch.
- H. Condensate drain pan: Pan shall be formed of welded austenitic stainless steel sheet material and provided with a welded stainless steel drain connection at the front for connection to a P trap. Drain pan shall be sloped in two directions to provide positive draining and drain connector shall be sealed at penetration through cabinet wall.
- I. P trap: Contractor shall provide, or fabricate, and install an appropriate P trap, in accordance with all local and area codes and Best Practices.
- J. Energy wheel: Energy wheel shall be of total enthalpy, rotary air-to-air type and shall be an element of a removable energy wheel cassette. The cassette shall consist of a galvanized steel framework (designed to produce laminar air flow through the wheel), an energy wheel as specified and a motor and drive assembly. The cassette shall incorporate a pre-tensioned urethane drive belt with a five year warranty. The wheel media shall be a polymer film matrix in a stainless steel framework and be comprised of individual segments that are removable for servicing. Non-segmented energy wheels are not acceptable. Silica gel desiccant shall be permanently bonded to the polymer film and is designed and constructed to permit cleaning and servicing. The energy wheel is to have a five year warranty. Performance criteria are to be as specified in AHRI Standard 1060, complying with the Combined Efficiency data in the submittal.
- K. Modulating frost control. Control system shall include an outdoor air thermostat and pressure sensor on the wheel assembly to initiate frost control sequence.
- L. Reheat coil with factory installed modulating hot gas reheat valve.

- M. Indirect gas furnace
1. Shall be ETL Certified as a component of the unit.
 2. Shall have an integral combustion gas blower.
 3. Shall be ETL Certified for installation downstream of a cooling coil.
 4. Shall have fault sensors to provide fault conditions to optional digital controller or building controls.
 5. Shall have 4-pass tubular heat exchangers, constructed of type 409 stainless steel. Heat exchanger tubes shall be installed on the vest plate by means of swaged assembly, welded connections are not acceptable. Heat exchanger tubes shall be supported by a minimum of two fabricated assemblies that support the tubes and also permit expansion and contraction of the tubes.
 6. Heat exchanger shall have a 5 year extended warranty.
 7. Furnace control shall be HighTurndown 12:1 Modulating.
 8. Shall be encased in a weather-tight metal housing with intake air vents. Large, metal lift-off door shall provide easy access to the enclosed vest plate, control circuitry, gas train, burner assembly and exhaust blower.
 9. Shall have solid state controls permitting stand-alone operation or control by building controllers.
- N. Packaged DX System: Unit shall have an integral compressor(s) and evaporator coil located within the weather-tight unit housing. Condenser coils and appurtenant condenser fan assemblies shall be factory installed as integral subassemblies of the unit and mounted on the exterior of the unit. Lead condenser fan shall have EC motor to maintain condenser pressure at part load conditions. Motors shall be UL Recognized and CSA Certified. The refrigerant compressor(s) shall be digital hermetic scroll-type and shall be equipped with liquid line filter drier, thermostatic expansion valves (TXV)(s), manual reset high pressure and low pressure cutouts and all appurtenant sensors, service ports and safety devices. Compressed refrigerant system shall be fully charged with R-410A refrigerant. Each compressor shall be factory-equipped with an electric crankcase heater to boil off liquid refrigerant from the oil.
- O. Packaged DX Control and Diagnostics: The Packaged DX system shall be controlled by an onboard digital controller (DDC) that indicates both owner-supplied settings and fault conditions that may occur. The DDC shall be programmed to indicate the following faults:
1. Global alarm condition (active when there is at least one alarm)
 2. Supply Air Proving alarm
 3. Dirty Filter Alarm
 4. Compressor Trip alarm
 5. Compressor Locked Out alarm

6. Supply Air Temperature Low Limit alarm
 - a. Sensor #1 Out of Range (outside air temperature)
 - b. Sensor #2 Out of Range (supply air temperature)
 - c. Sensor #3 Out of Range (cold coil leaving air temperature)
 - d. Supply set point is reset up/down based on return air temperature.
 - e. Economizer control (Modulate wheel or Stop Wheel) based on supply temperature and outdoor air temperature.
 - f. Wheel Frost Control: Enabled based on outdoor air temperature and wheel pressure drop. Control via preheat, wheel modulation, or timed exhaust.
 - g. Cooling-coil reset temperature (50F, adj) based upon humidistat.
 - h. Outside air and return air dirty filter switch input and alarm output.
 - i. Wheel rotation sensor and alarm output.
 - j. Network compatibility: BACnet.

- P. Phase and brownout protection: Unit shall have a factory-installed phase monitor to detect electric supply phase loss and voltage brown-out conditions. Upon detection of a fault, the monitor shall disconnect supply voltage to all motors.

- Q. Motorized dampers / Intake Air, Motorized dampers of low leakage type and shall be factory installed.

- R. Motorized Recirculating Air Damper designed to permit 100% recirculation of exhaust air shall be factory installed.

- S. Vapor Tight Lights: Provide service lights mounted in the unit to be used during times of routine maintenance. The lights must be wired by others on the jobsite, as they will not be wired through the unit control center.

2.4. BLOWER

- A. Blower section construction, Supply Air: direct drive motors and blowers shall be assembled on a 14 gauge galvanized steel platform and shall be equipped with 1.125 inch thick neoprene vibration isolation devices.

- B. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.

- C. Fan: Airfoil plenum fan statically and dynamically balanced, AMCA certified for air and sound performance, mounted on ground and polished steel fan shafts with ball bearing pillow blocks. Bearings shall be selected for a minimum L10 life in excess of 50,000 hours at maximum catalogued speeds.

- D. Blower section motor source quality control: Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency. Ratings are to be established in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Rating".

2.5. MOTORS

- A. General: Blower motors greater than 3/4 horsepower shall be "NEMA Premium" unless otherwise indicated. Compliance with EPAAct minimum energy-efficiency standards for single speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure.
- B. Motors shall be 60 cycle, 3 phase 208 volts.

2.6. UNIT CONTROLS

- A. The unit shall be constructed so that it can function as a stand-alone heating and cooling system controlled by factory-supplied controllers, thermostats and sensors or it can be operated as a heating and cooling system controlled by a Building Management System (BMS). This unit shall be controlled by a factory-installed microprocessor programmable controller (DDC) that is connected to various optional sensors.
- B. Unit shall incorporate a DDC controller with integral LCD screen that provides text readouts of status. DDC controller shall have a built-in keypad to permit operator to access read-out screens without the use of ancillary equipment, devices or software. DDC controllers that require the use of equipment or software that is not factory-installed in the unit are not acceptable. Alarm readouts consisting of flashing light codes are not acceptable. Owner-specified ventilating conditions can be input by means of pushbuttons.
- C. Unit supply fan shall be configured for CO2 sensor by factory.
- D. Unit exhaust fan shall be configured for
- E. Outside Air / Return Air damper control shall be
- F. Economizer control shall be temperature / dew point.
- G. Operating protocol: The DDC shall be factory-programmed for BACNetMSTP.
- H. Variable Frequency Drive (VFD): unit shall have factory installed variable frequency drive for modulation of the supply and exhaust air blower assemblies. The VFD shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate.
- I. Remote Interface: Contractor shall provide and install a Remote Interface that functions as a remote indicator of Owner-selected operating parameters and also permits remote inputting of new operating parameters. Each remote panel shall have a large LCD user interface screen similar in form and function to the screen on the DDC. Installed location of room display shall be as indicated on the plans.

2.7. FILTERS

- A. Unit shall have permanent metal filters located in the outdoor air intake and shall be accessible from the exterior of the unit. MERV 8 disposable pleated filters shall be provided in the supply air stream. MERV 8 disposable pleated filters shall be provided in the supply final air stream and MERV 8 filters in the exhaust air stream.

2.8. SEQUENCE OF OPERATION

- A. The stand-alone DDC controller shall perform the following control sequence.

2.9 UNIT START COMMAND

- A. Outdoor air and Exhaust air damper actuators are powered.
- B. Exhaust fan starts after a 10-second delay (adjustable).
- C. Supply fan starts 5 seconds (adjustable) after the exhaust fan.
- D. Heating, cooling, and wheel operation per below.

2.10 UNIT STOP COMMAND (OR DE-ENERGIZED)

- A. Supply fan, exhaust fan, tempering options, and wheel are de-energized.
- B. Outdoor air and Exhaust air damper actuators are de-energized and dampers spring return closed.

2.11 REMOTE ON/OFF

- A. Unit DDC shall have an input allowing the unit to be started/stopped by others.

2.12 OCCUPIED/UNOCCUPIED MODES

- A. Shall be based on a 7-day time clock internal to the controller. The schedule shall be set by the end user. When a user initiates an override input, the DDC would switch from unoccupied to occupied mode. The DDC will return to the schedule occupied/unoccupied mode after the override time has expired (60 min, adjustable). If the internal time clock is disabled, a remote contact or a BMS can control the occupied/unoccupied mode.

- 1. Occupied Mode:
 - a. Supply fan ON.
 - b. Exhaust fan ON.
 - c. Heating per below.
 - d. Cooling per below.
 - e. Wheel control per below.

- 2. Unoccupied Mode: Units Off

2.13 COOLING SEQUENCE

- A. The cooling is controlled to maintain the supply temperature set point. The mechanical cooling will be locked out when the outside air is $<55^{\circ}\text{F} - 2^{\circ}\text{F}$ hysteresis, adjustable.

- 1. DX Cooling: DDC will provide 1 or 2 stages of cooling to maintain supply air set point.

2.14 DEHUMIDIFICATION SEQUENCE

- A. The cooling is controlled to maintain the cooling-coil set point. The Dehumidification sequence will be locked out when the OA is $<10\text{F}$ above the cold-coil set point. The mechanical cooling will be locked out when the outside air is $<55^{\circ}\text{F} - 2^{\circ}\text{F}$ hysteresis, adjustable.

2.15 REHEAT SEQUENCE

- A. While the unit is in dehumidification mode, the outdoor air can be reheated via Modulating Hot gas Reheat for Space Neutral Applications.
 - 1. Modulating Hot Gas Reheat: The controller will send a 24 volt signal to the On/Off valve of the hot gas reheat coil, and also modulate the Hot Gas Reheat bypass damper with a 0-10 V signal to maintain the supply temperature set point.

2.16 HEATING SEQUENCE

- A. The heating is controlled to maintain the supply temperature set point. The heating will be locked out when the outside air is $>70^{\circ}\text{F} + 2^{\circ}\text{F}$ hysteresis, adjustable.

2.17 SUPPLY SET POINT RESET FUNCTION

- A. Duct Temperature Sensor: With a supply duct temperature sensor, the controller will adjust the supply temperature set point up/down accordingly to satisfy the desired duct temperature. Cooling and heating are determined by a difference in temperature of the duct temperature sensor compared to the desired duct temperature set point (adj.).

2.18 FREEZE PROTECTION

- A. If the supply air temperature drops below 35°F (adjustable), the DDC will de-energize the unit and activate the alarm output after a preset time delay. The hot water valve shall be positioned to full open.

2.19 ENERGY WHEEL SEQUENCE

- A. Economizer:
 - 1. Modulate Wheel: When economizer mode is enabled and there is a signal for cooling, the wheel VFD modulates wheel speed maintain the discharge temperature set point.
 - 2. The economizer will be locked out when: the outside air is $<40^{\circ}\text{F}$ (-2°F hysteresis, adjustable); the unit is operating in dehumidification mode; or there is a call for heating.

2.20 FROST CONTROL

- A. The DDC controller will output a signal when frosting is occurring which is determined by a temperature set point ($0\text{A}<5\text{F} - 2\text{F}$ hysteresis, adjustable) and wheel pressure drop increase.
 - 1. Preheat: When frosting is occurring, the preheater is energized to defrost the wheel. Once the pressure drop decreases below setpoint, the preheater de-energizes.

2.21 ALARMS INDICATION

- A. DDC shall have one digital output for remote indication of an alarm condition. Alarms shall include:
 - 1. Dirty Filter Alarm: If the outside air or return air filter differential pressure rises above the switch set point (adj.) the differential pressure switch shall signal the DDC to activate an alarm.
 - 2. Wheel Rotation Alarm: Monitors wheel rotation, and sends a signal to controller (after a 15 second time delay with no rotation) that signals the DDC to activate an alarm.

3. Supply and Exhaust Air Alarm: DDC monitors proving switch on each blower and displays an alarm in case of blower failure.
4. Dirty Wheel Alarm: DDC monitors pressure across the wheel and sends an alarm in the case of an increased pressure drop.
5. DX Alarm: DDC monitors the refrigerant pressure and shuts off refrigeration circuit in the case of high or low refrigerant pressure.
6. Temperature Sensor Alarm: DDC will send an alarm in the case of a failed air temperature sensor.

2.22 INDOOR ENERGY RECOVERY VENTILATOR (ERV-1)

A. GENERAL

1. Units shall be listed per ANSI/UL 1812, Heating and Cooling Equipment. Energy transfer ratings of the energy recovery wheel shall be ARI Certified. Ventilators shall bear the AMCA Certified Rating Seals for air performance. Performance to be as scheduled on plans.

B. CASING AND ACCESS

1. Unit shall be constructed of G90 galvanized steel. All components shall be easily accessible through removable access panels. Access to filters and energy wheel shall not require tools. Energy recovery wheel shall be mounted in a slide-out track for ease of inspection, removal and cleaning. Housing shall be insulated with 1/2-inch insulation. Outdoor air and exhaust air discharges shall have integral backdraft dampers. Duct adapters shall be factory installed on all four intake/discharge ports.

C. INTAKE LOCATION

1. Both the outdoor air and exhaust air intakes shall be designed for optional relocation in the field. Alternate intake location on adjacent side of the unit enables duct installation flexibility.

D. ENERGY RECOVERY WHEEL

1. Wheel shall be of the enthalpy type for both sensible and latent heat recovery and be designed to insure laminar flow. Energy transfer ratings must be ARI Certified to Standard 1060 and bear the ARI certification symbol for ARI Air-to-Air Energy Recovery Ventilation Equipment Certification Program based on ARI 1060. Ratings "in accordance with 1060" without certification are not acceptable. Desiccant shall be silica gel for maximum latent energy transfer. Wheel shall be constructed of lightweight polymer media to minimize shaft and bearing loads. Polymer media shall be mounted in a stainless steel rotor for corrosion resistance.
2. Silica gel desiccant shall be permanently bonded to wheel media to retain latent heat recovery after cleaning. Wheels with sprayed on desiccant coatings are not acceptable. Wheels with desiccant applied after wheel formation are not acceptable. Energy recovery device shall transfer moisture entirely in the vapor phase.
3. Energy recovery drive belt material shall be high strength urethane and shall be factory installed in a pre-stretched state, eliminating the need for field belt tension adjustment. Link style belts are not acceptable.

E. FANS AND MOTORS

1. Fans shall be double width, double inlet centrifugal, forward curved type. Fans shall be statically and dynamically balanced. Fan motors shall be 115 volt, single phase, thermally protected and be compatible for use with speed controller.

F. FILTERS

1. The outdoor air shall be filtered with a 1-inch deep, 30% efficient, disposable filter. Filter rack shall be internal to the unit and factory installed.

G. ELECTRICAL

1. All internal electrical components shall be factory wired for single point power connection. All electrical components shall be UL listed, approved, or classified where applicable and wired in accordance with the National Electrical Code.

H. WARRANTY

1. The energy recovery ventilator shall be warranted to be free from defects in material and workmanship for a period of two years from the date of start-up. The energy recovery wheel shall be warranted to be free from defects in material and workmanship for a period of five years from the purchase date. Motors shall be warranted by the motor manufacturer for a period of one year from the purchase date.

PART 3 - EXECUTION

3.1. EXAMINATION

- A. Prior to start of installation, examine area and conditions to verify correct location for compliance with installation tolerances and other conditions affecting unit performance. See unit IOM.
- B. Examine roughing-in of plumbing, electrical and HVAC services to verify actual location and compliance with unit requirements. See unit IOM.
- C. Proceed with installation only after all unsatisfactory conditions have been corrected.

3.2. INSTALLATION

- A. Installation shall be accomplished in accordance with these written specifications, project drawings, manufacturer's installation instructions as documented in manufacturer's IOM, Best Practices and all applicable building codes.

3.3. CONNECTIONS

- A. In all cases, industry Best Practices shall be incorporated. Connections are to be made subject to the installation requirements shown above.
- B. Piping installation requirements are specified in Division 22 (Plumbing). Drawings indicate general arrangement of piping, fittings and specialties.
- C. Duct installation and connection requirements are specified in Division 23 of this document.
- D. Electrical installation requirements are specified in Division 26 of this document.

3.4. FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory authorized service representative to inspect field assembled components and equipment installation, to include electrical and piping connections. Report results to A / E in writing. Inspection must include a complete startup checklist to include (as a minimum) the following: Completed Start-Up Checklists as found in manufacturer's IOM.

3.5. START-UP SERVICE

- A. Engage a factory authorized service representative to perform startup service. Clean entire unit, comb coil fins as necessary, install clean filters. Measure and record electrical values for voltage and amperage. Refer to Division 23 "Testing, Adjusting and Balancing" and comply with provisions therein.

3.6. DEMONSTRATION AND TRAINING

- A. Engage a factory authorized service representative to train owner's maintenance personnel to adjust, operate and maintain the entire unit. Refer to Division 01 Section Closeout Procedures and Demonstration and Training.

END OF SECTION 237414

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SECTION 238219 - FAN COIL UNITS

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 fan-coil units and accessories.

1.3 DEFINITIONS

- A. BAS: Building automation system.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Ceiling suspension components.
 - 2. Structural members to which fan-coil units will be attached.
 - 3. Method of attaching hangers to building structure.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Items penetrating finished ceiling, including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Access panels.
 - 6. Perimeter moldings for exposed or partially exposed cabinets.

- D. Samples for Initial Selection: For units with factory-applied color finishes.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For fan-coil units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.
- G. Warranty: Two years from date of substantial completion.

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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.6 COORDINATION

- A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate size and location of wall sleeves for outdoor-air intake.

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. Fan-Coil-Unit Filters: Furnish 1 spare filter for each filter installed.
 - 2. Fan Belts: Furnish 1 spare fan belt for each unit installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Trane (basis of design)

- b. Carrier Corporation
- c. Marlo Coil; Subsidiary of Engineered Support Systems, Inc.
- d. McQuay International
- e. YORK International Corporation

2.2 DUCTED FAN-COIL UNITS

- A. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.
- B. Coil Section Insulation: 1-inch thick foil-faced glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
 - 1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
 - 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
- C. Drain Pans: Stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1-2004.
- D. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panels.
- E. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.
 - 1. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis.
 - 2. Return-Air Plenum: Sheet metal plenum finished to match the chassis.
 - 3. Mixing Plenum: Sheet metal plenum finished and insulated to match the chassis with outdoor- and return-air, formed-steel dampers.
 - 4. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.
- F. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 1. Pleated Cotton-Polyester Media: 90 percent arrestance and 7 MERV.
- G. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.
- H. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

- I. Belt-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
 - 1. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- J. Factory, Hydronic Piping Package: ASTM B 88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
 - 1. Two-way, modulating control valve for dual temperature water coil.
 - 2. Hose Kits: Minimum 400-psig working pressure, and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.
 - a. Length: 24 inches.
 - b. Minimum Diameter: Equal to fan-coil-unit connection size.
 - 3. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
 - 4. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig working pressure, 250 deg F maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and equipped with a memory stop to retain set position.
 - 5. Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig working pressure at 250 deg F; with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig.
 - 6. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig working pressure, with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in drain connection.
 - 7. Wrought-Copper Unions: ASME B16.22.
- K. Control devices and operational sequence are specified in Division 23 Section "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."
- L. Basic Unit Controls:
 - 1. Control voltage transformer.
 - 2. Wall-mounting thermostat with the following features.
 - a. Heat-cool-off switch.
 - b. Fan on-auto switch.
 - c. Fan-speed switch.
 - d. Automatic changeover.
 - e. Adjustable deadband.
 - f. Exposed set point.
 - g. Exposed indication.

- h. Degree F indication.
- 3. Wall-mounting temperature sensor.
- 4. Unoccupied-period-override push button.
- 5. Data entry and access port.
 - a. Input data includes room temperature, and humidity set points and occupied and unoccupied periods.
 - b. Output data includes room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.
- M. DDC Terminal Controller:
 - 1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
 - 2. Unoccupied Period Override Operation: Two hours.
 - 3. Unit Supply-Air Fan Operation:
 - a. Occupied Periods: Fan runs continuously.
 - b. Unoccupied Periods: Fan cycles to maintain room setback temperature.
 - 4. Hydronic-Cooling-Coil Operation:
 - a. Occupied Periods: Modulate control valve to maintain room temperature.
 - b. Unoccupied Periods: Close control valve.
 - 5. Controller shall have volatile-memory backup.
- N. BAS Interface Requirements:
 - 1. Interface relay for scheduled operation.
 - 2. Interface relay to provide indication of fault at the central workstation.
 - 3. Provide BACnet interface for central BAS workstation for the following functions:
 - a. Adjust set points.
 - b. Fan-coil-unit start, stop, and operating status.
 - c. Data inquiry including supply- and room-air temperature.
 - d. Occupied and unoccupied schedules.
- O. Electrical Connection: Factory wire motors and controls for a single electrical connection.

- P. Capacities and Characteristics:
 - 1. Refer to Drawings:

2.3 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. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

2.4 CABINET FAN COIL UNITS

- A. Fan Coil Unit Configurations:
 - 1. Dual Temperature Coils: with two-pipe system.
- B. Coil Section Insulation: 1-inch thick, complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
 - 1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
 - 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Coil Section Insulation: Insulate coil section according to Section 230616 "HVAC Equipment Insulation."
 - 1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
 - 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. [Main and Auxiliary]Drain Pans: Insulated galvanized steel with plastic liner. Fabricate pans and drain connections to comply with ASHRAE 62.1. Drain pans shall be removable.
- E. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panel. Floor-mounting units shall have leveling screws.
- F. Cabinet: Steel with baked-enamel finish in manufacturer's custom paint color as selected by Architect.
 - 1. Vertical Unit Front Panels: Removable, steel, with integral stamped discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.
 - 2. Steel recessing flanges for recessing fan coil units into ceiling or wall.

- G. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.
 - 1. MERV Rating: 7 when tested according to ASHRAE 52.2.
- H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
- I. Fan and Motor Board: Removable.
 - 1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
 - 2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 3. Wiring Termination: Connect motor to chassis wiring with plug connection.
- J. Factory, Hydronic Piping Package: ASTM B 88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
 - 1. Two-way, modulating control valve for dual-temperature coil.
 - 2. Hose Kits: Minimum 400-psig working pressure and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.
 - a. Length: 24 inches.
 - b. Minimum Diameter: Equal to fan coil unit connection size.
 - 3. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
 - 4. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig working pressure, 250 deg F maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and a memory stop to retain set position.
 - 5. Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig working pressure at 250 deg F; with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig.
 - 6. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in drain connection.
 - 7. Wrought-Copper Unions: ASME B16.22.
 - 8. Risers: ASTM B 88, Type L copper pipe with hose and ball valve for system flushing.
- K. Control devices and operational sequences are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

- L. Basic Unit Controls:
 - 1. Control voltage transformer.
 - 2. Unit-mounted thermostat with the following features:
 - a. Heat-cool-off switch.
 - b. Fan on-auto switch.
 - c. Fan-speed switch.
 - d. Automatic changeover.
 - e. Adjustable deadband.
 - f. Exposed set point.
 - g. Exposed indication.
 - h. Degree F indication.
 - 3. Wall-mounting temperature sensor.
 - 4. Unoccupied-period-override push button.
 - 5. Data entry and access port.
 - a. Input data includes room temperature, and humidity set points and occupied and unoccupied periods.
 - b. Output data includes room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.

- M. [DDC]Terminal Controller:
 - 1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
 - 2. Unoccupied-Period-Override Operation: Two hours.
 - 3. Unit Supply-Air Fan Operation:
 - a. Occupied Periods: Fan runs continuously.
 - b. Unoccupied Periods: Fan cycles to maintain room setback temperature.
 - 4. Dual-Temperature Hydronic-Coil Operation:
 - a. Occupied Periods: When chilled water is available, modulate control valve if room temperature exceeds thermostat set point. When hot water is available, open control valve if temperature falls below thermostat set point.

- b. Unoccupied Periods: When chilled water is available, close control valve. When hot water is available, modulate control valve if room temperature falls below thermostat setback temperature.
- 5. Controller shall have volatile-memory backup.
- N. Electrical Connection: Factory wire motors and controls for a single electrical connection.
- O. Capacities and Characteristics:
 - 1. Refer to the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fan-coil units level and plumb.
- B. Install fan-coil units to comply with NFPA 90A.
- C. Suspend fan-coil units from structure with elastomeric hangers. Vibration isolators are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- D. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 - 1. Install piping adjacent to machine to allow service and maintenance.
 - 2. Connect piping to fan-coil-unit factory hydronic piping package. Install piping package if shipped loose.
 - 3. Connect condensate drain to indirect waste.
 - a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.
- B. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Division 23 Section "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. 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.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 238219

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SECTION 250000 – INTEGRATED AUTOMATION

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 a summary of all Integrated Automation which is principally Direct Digital Control (DDC System) related work.
- B. Related Sections:
 - 1. 25 05 01 – COMMON WORK RESULTS FOR INTEGRATED AUTOMATION
 - 2. 25 09 90 – SEQUENCE OF OPERATION
- C. Work by Others:
 - 1. The following work will be done by other contractors, as specified under respective headings, which this contractor shall read to ascertain what is called for therein:
 - a. HVAC
 - b. Electric
 - c. Plumbing
 - 2. The Integrated Automation Work shall be a subcontract to the HVAC Contractor.

1.3 GENERAL

- A. This contract shall include the furnishing of all labor and materials required for the installation of new temperature regulating systems to monitor, control, and regulate automatically and completely the new chiller, as shown on the accompanying drawings and hereinafter specified. The temperature control equipment shall be installed by trained mechanics and technicians employed by the manufacturer and working in conjunction with the other contractors.
- B. Bids for the temperature control work, hereinafter specified, shall be based upon a Siemens direct digital control system with electronic sensors for indication and control functions, electrically actuated devices including new valves, etc., and all connections to sensors and actuated devices. All bidders of controls shall comply with this specification and shall provide any additional labor, hardware, software, programming, network integrators, etc., to communicate with, control and display graphically the new systems.
- C. Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this project.

- D. The BMS as provided shall incorporate, at minimum, the following integrated features, functions and services:
1. Operator information, alarm management and control functions.
 2. Enterprise-level information and control access.
 3. Information management including monitoring, transmission, archiving, retrieval, and reporting functions.
 4. Diagnostic monitoring and reporting of BMS functions.
 5. Offsite monitoring and management access.
 6. Energy management.
 7. Standard applications for terminal HVAC systems.
- E. Acceptable Manufacturers and Installers:
1. Siemens Controls.
- F. The BMS Contractor shall be a recognized national manufacturer, installer and service provider of BMS. The BMS Contractor shall have a branch facility within a 50-mile radius of the job site supplying complete maintenance and support services on a 24 hour, 7-day-a-week basis.
- G. The Building Management System architecture shall consist of the products of a manufacturer regularly engaged in the production of Building Management Systems, and shall be the manufacturer's latest standard of design at the time of bid.
- H. The new systems shall be complete with all piping connections, switches, relays, wiring, or other devices required to accomplish the required results. All control devices shall be of the manufacturer's best construction. Complete shop drawings of the control system shall be submitted for approval. Contractor shall become thoroughly familiar with interconnections, with equipment specified under other sections of this specification including electric work, and all work furnished by the Direct Digital Control Contractor shall be coordinated therewith.

1.4 PROJECT CONDITIONS

- A. Alterations and Additions to DDC Systems
1. The contract shall include new work as shown, specified, or required, and shall include, but not limited to, the following principle components:
 - a. Provide complete system for control of all equipment and systems as specified herein for Base Bid and Alternate Bids.
 - b. Furnish and install all requisite wells and devices for temperature, pressure, alarm, indication, etc.
- B. Shop Drawings
1. As soon as possible after award of the contract, and prior to fabrication, the contractor shall prepare complete shop drawings of the DDC systems, which shall in general conform to the bidding documents; any deviations deemed necessary by the contractor shall be noted and agreed upon prior to starting the work.
 2. In preparing his working drawings, the contractor shall coordinate the location of all equipment and devices with the other contractors. Drawings shall show ceiling grids, lights, registers, grilles, heat detection devices, access panel, skylights, etc. Any changes in fabricated DDC layout occasioned by lack of coordination shall be made by the contractor at no change in the contract price.
 3. Drawing shall be on 11" x 17" or 18" x 24" sheets at the contractor's option.
 4. All submittals shall be in PDF format and routed through the Engineer.

5. The submittals shall include control diagrams of all equipment that is to be controlled, monitored, etc. The submittal shall include all of the control information for chiller, variable frequency drives, etc.
 6. The contractor shall implement all control sequences specified and indicated on the input/output schedules.
 7. Each input/output device shall have a unique identifier which shall be permanently labeled on or adjacent to the device. The unique identifier shall be labeled on the various submittals as well.
- C. Restoration Of Surfaces
1. Refer to Division 01.
- D. Guarantee
1. This contractor shall guarantee all workmanship, materials, and equipment entering into this contract for a period of two years; all from date of substantial completion or from the "recognized" start-up date, whichever is later. Should the Owner elect to accept a portion of work prior to the date of substantial completion, the guarantee period for the accepted portion of the work shall commence on the date of acceptance or on the "recognized" start-up date for that portion of the work, whichever is later. If the specifications dictate a different period of guarantee for a given component or piece of equipment, the more stringent requirements shall govern.
 2. The "recognized" start-up date shall be defined as that date on which the contractor has successfully completed all phases of his work, including the following:
 - a. Submitted and received approval of three (3) copies of the Instruction Booklets.
 - b. Submitted complete "As-Built" drawings.
 - c. Completed all testing, cleaning, adjusting, and trial run. This testing shall include the successful completion of all commissioning tasks.
 3. In the case where the Engineer is accepting a portion of the work, the contractor shall have completed all phases of that portion of the work to be accepted, including Items above, for that accepted portion of the work.
 4. Any workmanship, materials, or equipment proving to be defective during this guarantee period shall be made good by this contractor without additional cost to the Owner.
- E. Equipment
1. Any and all costs associated with piping, electric, wiring, conduit, supports, pads, or other modifications to accommodate installation for manufacturer's equipment that differs from equipment layout on drawings shall be included on contractor's bid. The contractor is responsible to insure that the equipment will fit within space allocated with appropriate clearances for maintenance, operation, servicing, and code.
- F. Schedule
1. The contractor shall be responsible to meet the project schedule as stated by the Owner. The contractor shall include in his bid the cost associated with all requisite coordination.
 2. In addition, the contractor must prepare a schedule for his work that integrates with the Mechanical Contractor's schedule. The contractor shall update progress and revise schedule at least twice monthly.

3. This contractor shall be responsible to expedite any materials and work any overtime in order to meet the schedule. The cost for any expediting of overtime work shall be included in his bid.
4. Refer to Section 23 00 00 for a detailed project schedule.

1.5 FUNCTIONAL PERFORMANCE TEST

- A. The Functional Performance test (FPT) shall be executed by the Contractor and approved by the Owner. If the project is phased, then a separate test plan shall be executed for each phase. Use FPT sample procedures, designated by the Commissioning Agent, as a guide to creating the test plan spreadsheets.
- B. Obtain written approval of the Functional Performance Test plan for each phase of testing before beginning that phase of testing. Give the Commissioning Agent written notification of planned testing at least 30 days prior to the test but not before completion of any test and balance (TAB) requirements have been completed. Notification shall be accompanied by the proposed test procedure, a verified Pre-performance Testing Checklist, and a written estimated time table required to perform the test. After the written notification is received, the Commissioning Agent shall convene a meeting with the Contractor and the Owner at least 14 days prior to testing. In no case will the Contractor be allowed to start testing without written Owner approval of the Functional Performance Test plan.
- C. Demonstrate compliance of the heating, ventilating, and air conditioning control system with the contract documents including proper labeling of controls and wiring. Furnish personnel, equipment, instrumentation, and supplies necessary to perform calibration and site testing. Ensure that test personnel are regularly employed in the testing and calibration of DDC systems.
- D. Functional Performance testing will include, but not be limited to, workstation operations, calibration results for input and output devices required by manufacturer, proper tuning of control loops, and ensuring proper execution of the sequence of operation. Use the BACnet protocol analyzer during the performance testing to demonstrate communications reliability.
- E. The Pre-performance Testing Checklist shall be used as the Contractor's guide to prepare for the FPT and to guide discussions at the pre-performance test meeting between the Contractor and the Owner. Every item on the check list shall be validated by the Contractor's QC representative prior to the test meeting.
- F. Verify all workstations, notebook computers, and maintenance personnel interface tools have been delivered, all system and database software installed, and graphic pages created for each workstation and notebook computers. Notify the Owner when phone lines or network connections are needed at least 30 days prior to installation of the workstation.
 1. Verify integrity/safety of all electrical connections.
 2. Verify proper communications over network segments and between controllers.
 3. Co-ordinate with TAB contractor to obtain control settings that are determined from balancing procedures.
 4. Test, calibrate, and set all digital and analog sensing and actuating devices as required.
 5. Check and set zero and span adjustments for all actuating devices as required.
 6. Check each digital controller for stand-alone operation by temporarily removing from the network.
 7. Check proper sequences have been installed and tested.
 8. Check all control loops have been properly tuned.
 9. Check all alarms are programmed and routed to their proper destination.

10. Check all trends are operating for each item marked for trending on the points list.
 11. Check all schedules are operating for each item marked for schedules on the points list.
 12. Complete all "as-built" record drawings and I/O points list.
- G. The test procedure reporting documents shall be developed by the Contractor and based specifically on the control system installed in a spread sheet format allowing sufficient space for individual testing of each area of the control system. List the test procedure and the expected response for each piece of equipment and system in each test area specified. Develop a separate row or column for each item that is required to be "demonstrated" within a test area. Allow ample space for comments, pass, fail, and retest lines. Each area of testing shall have four signature lines, one for the Contractor's QC representative, the Contractor's FPT administrator, the Commissioning Agent representative, and the Owner to acknowledge successful completion for each test area. Include references to the paragraph number or drawing number in the contract documents for each item or group of items to be tested. BACnet protocol analyzer test results shall be included with the test reporting. During and after completion of the Functional Performance Test, identify, determine causes, replace, repair or calibrate equipment that fails to meet the specification, and submit a written report to the Owner.
- H. Document all tests with detailed test results. Explain in detail the nature of each failure and corrective action taken. Provide a written report containing test documentation after the Functional Performance Test. Schedule a meeting with the Owner to present the results to the Owner after all failures have been corrected. Based on the report and test review meeting, the Owner will determine the successful completion of the testing. If retesting of any portion of the FPT is required, do not retest until after receipt of written notification by the Owner. At the conclusion of retest, assessment will be repeated. The Owner reserves the right to require retesting of 100 percent on every component in the system when results from sampled areas are found deficient. Final test results will be submitted in electronic format on CD media.
- I. Using the completed shop drawings and the FPT spreadsheet, conduct the performance verification test to demonstrate workstations and network communications are operating correctly, control system maintains set points, control loops are tuned, and controllers are programmed for the correct sequence of operation. The test report shall include the required four authorization signatures for successful completion of each test area. Test areas may have several sub-areas and each shall be fully satisfied to receive approval. Specifically the FPT consists of the individual test areas below and shall demonstrate the following:
- J. Controller Capability, Accessibility, and Labeling
1. Memory: Demonstrate that programmed data, parameters, and trend/alarm history collected during normal operation is not lost due to power failures.
 2. Direct Connect Interface: Demonstrate the ability to connect directly to each type of digital controller with a notebook computer. Demonstrate that maintenance personnel interface tools perform as specified in the Manufacturer's technical literature.
 3. Wiring and AC Power: Demonstrate the ability to disconnect any controller safely from its power source using the AC Power Table.
 4. Demonstrate the ability to match wiring labels easily with the control drawings. Demonstrate the ability to locate a controller's location using the riser communications diagram in the control drawings.
 5. Nameplates and Tags: Demonstrate the nameplates and tags bearing device unique identifiers are accurate and permanently attached to HVAC the control panel doors and back plates. Demonstrate that plastic or metal tags have the correct equipment name and point identifier.
- K. Workstation and Software Operation
1. BACnet Communications and Interoperability Areas

- a. Demonstrate proper functioning of the five interoperability areas of data sharing, alarm and event management, trending, scheduling, and device and network management. Use the BACnet protocol analyzer to demonstrate that communications are free from errors and that devices from different manufacturers are interoperable. These requirements shall be met even if there is only one manufacturer's equipment installed.
2. If system can only be programmed at the operator workstation, then two of these workstations shall be provided and included in the base bid.

L. Data Sharing

1. Data Presentation - On each web server workstation, demonstrate graphic display capabilities as follows: Each graphic page shall initially display with current data within 5 seconds over a web-based browser connection and 15 seconds after a dial-up modem connection is established. Updated information shall occur when a change of value (COV) notification is received or, if COV is not implemented, within 15 seconds. Demonstrate that any data value from any networked device shall be available for plotting at a workstation in real time. Select binary and analog data concurrently and plot multiple instances of each data type on the same screen. Demonstrate the ability to select sampling intervals from 10 seconds to 60 minutes. For devices that implement COV reporting, select this as the means to update the plot.
2. Monitoring of Any Property - Demonstrate the ability to display any value of any property of any object from any networked device including all properties required by BACnet, all supported optional properties, and any proprietary extensions. Compare the difference between properties shown on the operator workstation over the network and the properties shown when directly connected to the controller in the field.
3. Set point and Parameter Modifications - Demonstrate the ability to modify all control loop set points and tuning parameters via BACnet messages initiated through operator interaction with graphics displays. Compare the difference between parameters modified on the operator workstation over the network and the parameters modified when directly connected to the controller in the field.
4. Peer-to-Peer Data Dependencies - Demonstrate all BACnet devices are installed and configured to exchange data values directly, without the need for operator or workstation intervention, to implement the sequence of operations specified in the mechanical system drawings and to share global data values.

M. Alarm and Event Management

1. Alarm Lists - Demonstrate that alarms are installed and configured to detect alarms and events for the points indicated in the system drawings and are prioritized according to the standardized list designated by the Owner. Demonstrate system alarms, such as offline controllers are generated. Demonstrate software logic has been set up to avoid nuisance alarms, e.g., no temperature or status alarms shall be generated when fan systems are not running, or during start-up and shut-down transitions. Demonstrate that delays between the occurrence of an alarm condition and its annunciation are adjustable. Demonstrate alarms appear at any local workstation within 5 seconds over a web-based browser connection and 15 seconds on a dial-up modem connection. Demonstrate workstations display an alarm message window that appears on top of any other open windows and alarm message window has a distinctive color and appearance to attract the operator's attention. Demonstrate alarms that require operator acknowledgment and cause the alarm window to remain active until such an acknowledgment is received and when multiple alarms are received, unacknowledged alarms shall be displayed on a first-come first-served basis grouped by priority, with the highest priority alarms displayed first.
2. Alarm Parameter Adjustment - Demonstrate the ability for operators (with sufficient privilege) to change alarm parameters for all standard BACnet event types.
3. Alarm Routing Adjustment - Demonstrate the ability for operators (with sufficient privilege) to change alarm routing (BACnet notification classes) for each alarm including the destination for each type of alarm

and alarm priority, the day of week and time of day, and the type of transition involved (TO-OFFNORMAL, TO-NORMAL, etc.).

N. Scheduling

1. Schedule Lists - Demonstrate that schedules are installed and configured start/stop, mode change, and night setback schedules as defined in the sequence of operations including holidays. Demonstrate the ability to program alterations to programmed operating schedules based on the priority of events, including the ability to temporarily override the programmed schedule of equipment. Demonstrate operational override of a programmed schedule shall be for a specific duration following which the schedule shall revert back to the preprogrammed schedule.
2. Display of Start/Stop Times and Actions -Demonstrate the ability to inspect the content of any schedule and determine the specific control actions that will occur at any time, on any date.
3. Modification of Schedules - Demonstrate that all calendar entries and schedules shall be modifiable from any local workstation by an operator with sufficient privilege.

O. Trending

1. Archival Storage of Data - Demonstrate that archival storage of data will be handled by the operator workstation/server. Demonstrate that local trend archiving and display can be accomplished through the use of BACnet Trend Log objects.
2. Modification of Trend Log Parameters - Demonstrate that an operator with sufficient privilege shall be able to change the data points to be logged, the sampling rate, and the duration of a trend log.

P. Device and Network Management

1. Display of Device Status Information - Operators shall be able to display at any time the operational status of any device on the network.
2. Display of BACnet Object Information - Operators shall be able to display at any time any property of any BACnet object. Operators shall be able to display property values of objects grouped by object type, object location, and building system.
3. Silencing Devices that are Transmitting Erroneous Data -Operators shall be able to direct a field device to stop transmitting event, alarm, or COV notifications until a subsequent command to resume transmissions is received.
4. Time Synchronization - Operators shall be able to set the time and date in any device on the network that supports time-of-day functionality. The operator shall be able to select to set the time and date for an individual device or all devices on a single local network.
5. Remote Device Re-initialization - Operators shall have the ability to issue re-initialization commands to any device that supports remote reinitialization.
6. Backup and Restore - Operators shall have the ability to backup and restore all BACnet devices on the network that support this capability.

Q. Execution of Sequence of Operation - Demonstrate the HVAC system operates properly through the complete sequence of operation. Insert the complete sequence of operation into the PVT spreadsheet with spaces between each line to allow for observations and comments.

- R. Control Loop Stability and Accuracy - Furnish the Owner graphed trends of control loops to demonstrate the control loop is stable and that setpoint is maintained. Control loop response shall respond to setpoint changes of 10 percent and stabilize in 3 minutes or less. Control loop trend data shall be in real time and the time between data points shall not be greater than one minute.

- S. Stand-alone Capability - Demonstrate stand-alone controller capability for each central mechanical system, each air handler, and each zone. Zones with identical controllers and identical sequences may be randomly tested one controller per zone. Controllers shall provide stable and reliable stand-alone operation using default values or other method for values normally read over the network. Verify that a system alarm is generated indicating the communications failure for each controller in a stand-alone state.

END OF SECTION 250000

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SECTION 250501 – COMMON WORK RESULTS FOR INTEGRATED AUTOMATION

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. Integrated Automation equipment coordination and installation.
 - 2. Sleeves for raceways and cables.
 - 3. Sleeve seals.
 - 4. Grout.
 - 5. Common Integrated Automation installation requirements.
- B. Related Sections:
 - 1. 25 00 00 – INTEGRATED AUTOMATION
 - 2. 25 09 90 – SEQUENCE OF OPERATION

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For sleeve seals.

1.5 COORDINATION

- A. Coordinate arrangement, mounting, and support of Integrated Automation equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.

4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for Integrated Automation items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 3. Pressure Plates: Carbon steel. Include two for each sealing element.
 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 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.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR INTEGRATED AUTOMATION INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both Integrated Automation equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR INTEGRATED AUTOMATION PENETRATIONS

- A. Integrated Automation penetrations occur when raceways, pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".

- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use 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.

3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for Integrated Automation installations to restore original fire-resistance rating of assembly.

END OF SECTION 250501

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SECTION 250990 – SEQUENCE OF OPERATION

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 a summary of all Integrated Automation which is principally Direct Digital Control (DDC System) related work.
- B. Related Sections:
 - 1. 25 00 00 – INTEGRATED AUTOMATION
 - 2. 25 05 01 – COMMON WORK RESULTS FOR INTEGRATED AUTOMATION

1.3 SUMMARY OF WORK

- A. This contract shall include the furnishing of all labor and materials required for the installation of new temperature regulating systems to monitor, control, and regulate automatically and completely the new air conditioning, ventilating, hydronic and heating systems, as shown on the accompanying drawings and hereinafter specified. The temperature control equipment shall be installed by trained mechanics and technicians employed by the manufacturer and working in conjunction with the other contractors.
- B. The Integrated Automation Contractor shall extend all requisite power and control wiring in conduit to the devices, equipment, panels, workstation, servers, etc. that are provided under their contract.
- C. The Integrated Automation Contractor shall provide all interface equipment required for interconnectivity of their system to the equipment, panels, servers, workstation, meters, etc. that are part of the Owner's system.
- D. The Integrated Automation Contractor shall coordinate installation of all devices, meters, sensors, etc. with other contractors and their systems.

1.4 CONTROLS FOR FAN COIL UNITS (CONCEALED TYPE)

- A. Occupied
 - 1. The supply fan will run at low speed.
 - 2. On call for heat, the discharge air temperature will maintain set point.
- B. Unoccupied
 - 1. The supply fan will be off. On a call for heat when the outdoor temperature is below 32°F, the hot water valve will be open 10% per 1.8°F (100% at 14°F).

C. Heat – Modulated

1. The supply fan will run and the valve will modulate open or closed based on the demand from the heat PID loop.

D. Cool – Modulated

1. The supply fan will run and the chilled water valve will modulate open or closed based on the demand from the cool PID loop.

1.5 SYSTEM INPUT/OUTPUT SCHEDULES

- A. Refer to Input/Output Schedule.

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CONTROL SYSTEM POINTS - INPUT/OUTPUT SUMMARY										
FOR BUENGER HALL RENOVATION										
XAVIER UNIVERSITY										
DEVICE MARK	CONTROL POINTS	INPUTS/OUTPUTS			CONTROL MONITOR	ALARM	DATA	DETAIL	COMMENTS	
		AI	DI	DO						AO
	POINT NAME DESCRIPTION									
	DUCTED FAN COIL UNITS: 5 NEW UNITS									
FAN	FAN ENABLE/DISABLE			X	X			M2.0		
T-1	ROOM TEMPERATURE SENSOR	X								
TT-1	SUPPLY AIR TEMPERATURE TRANSMITTER	X			X					
TCV	DUAL WATER TEMPERATURE CONTROL VALVE				X					

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SECTION 260000 – ELECTRICAL WORK

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. This Section includes a summary of all Electrical related work.
- B. Related Sections:

1. 260400 – General Electrical Requirements
2. 260500 – General Electrical Provisions
3. 260512 – Electrical Powered Equipment
4. 260519 – Wires and Cables
5. 260526 – Grounding and Bonding
6. 260529 – Supporting Devices
7. 260533 – Raceway and Boxes
8. 260534 – Junction and Pull Boxes
9. 260535 – Raceway Fittings
10. 260553 – Electric Identification
11. 260800 – Commissioning of Electrical Systems
12. 260923 – Lighting Control Devices
13. 262200 – Low-Voltage Transformer
14. 262416 – Switchboards and Panelboards
15. 262726 – Wiring Devices
16. 262730 – Taps, Splices, and Terminations
17. 262813 – Fuses
18. 262816 – Enclosed Switches
19. 262913 – Motor Starters
20. 263213 – Engine Generator
21. 264113 – Lightning Protection
22. 265119 – LED Interior Lighting
23. 265219 – Emergency and Exit Lighting
24. 269999 – Digital, Addressable Fire-Alarm System

1.3 DESCRIPTION

- A. The General Conditions, Special Conditions and Division 1 through Division 32, as set forth in these specifications, are hereby incorporated into and shall become a part of the specifications for work under this title, insofar as they apply hereto.
- B. Furnish material, labor, tools, accessories and equipment to complete and leave ready for operation all Electrical systems for this project as described in these specifications and as shown on the drawings, or as required.

1.4 SCOPE OF WORK

A. Work includes, but is not limited to:

1. Install new breakers in existing switchboards and panelboards. Extend new feeders from existing switchboards and panelboards to new mechanical equipment, as indicated on the drawings.
2. Furnish and install new variable frequency drives furnished by HVAC Contractor (AHU unit manufacturer). Extend new feeders as indicated on the drawings.
3. Extend new power branch circuits to all new mechanical equipment.
4. Provide certain new lighting fixtures and extend branch circuit wiring as indicated on the drawings. Provide manual transfer switch.
5. Provide new lighting control system consisting of relay panels, contactors, occupancy sensors, vacancy sensors, etc. and extend branch circuit wiring as indicated.
6. Provide new lightning protection system as part of Alternate Bid No. 3.
7. Remove certain existing convenience receptacles, provide new convenience receptacles and extend branch circuit wiring as indicated.
8. Modify and expand the existing fire and smoke detection and alarm system. Remove certain existing fire alarm devices in remodeled area. Provide new fire alarm devices in remodeled area and extend wiring as indicated. All existing fire alarm devices in remainder of building shall remain operational and shall become a part of the new fire alarm work.
9. Provide new voice fire alarm system, as part of Alternate Bid No. 2, while maintaining the existing fire alarm systems. Provide temporary interconnection of the existing systems to the new system to ensure complete notification coverage and detection throughout the multiple phases of the project. Include temporary relocation of existing fire alarm panels and equipment as needed to maintain full system operation throughout the duration of construction.
10. Provide communication and informational conduit system as indicated on the drawings.
11. Perform certain specialized Electric Work for the following other trades. Note, this listing is by no means meant to include each minute detail, but it is intended to alert the Electric Contractor to certain items. This contractor shall review each other division of work to ascertain the scope of electrical work specified therein:
 - a. General Contractor and Owner Furnished Equipment.
 1. Refrigerators, Freezers, Ice Machines, Microwave Ovens, Toasters, Office Equipment, etc.: Provide convenience outlets, where required for ease of connection to each item, and extend 120 volt connection thereto.

- b. Mechanical Equipment:
 - 1. Extend power branch circuit wiring to new fan coil units, energy recovery ventilator, roof top unit, etc. as indicated on the drawing.
 - 2. Extend 120 volt dedicated circuit wiring to all DDC temperature control panel locations.
- 12. Perform start-up for all electrical systems and commission same in accordance with the commissioning requirement.
- 13. Provide and/or participate in training of Owner's personnel on the use of all new electrical systems.
- 14. The contractor shall exercise adequate protective and safety measures for all persons and property and shall be responsible for any damages or injuries arising from the execution of this work.
- 15. Alterations and additions to existing work shall include the requisite dismantling of the old equipment, rigging, wrecking, hauling, protections of permanent equipment and the building structures, and cleaning up. Care shall be exercised to keep dust and dirt to a minimum and to confine it to the area where the removal work is being performed. All debris shall be promptly removed.
- 16. If asbestos insulation is encountered on any existing wiring which is to be removed or remodeled, contractor shall immediately notify Owner of the existence of asbestos and Owner will arrange proper removal of same without cost to contractor.
- 17. Unless otherwise noted, remove all other existing equipment and piping, valves, fittings, etc. which will not be reused in the final arrangement. Unless otherwise noted, all items which will be removed by this this contractor and not reused shall become the property of the contractor and shall be promptly removed from the site by him.
- 18. The existing facility will be partially occupied and will remain in operation throughout the period that this work is being performed, and certain new work will be performed during this period. Unscheduled interruptions of the facility will not be tolerated. The contractor shall exercise extreme caution, shall thoroughly inform his workmen and subcontractors of the critical nature of this work, and shall continually review the work procedure being followed in order to prevent accidental interruption of service. Before performing any act which could result in interruption of service, the contractor shall notify the Owner and Engineer of the hazards involved and the contractor shall proceed in a manner and at a time specifically approved by the Owner and Engineer.
- 19. All work necessitating the temporary turning off or shutting down the operation of existing mechanical and/or electrical facilities shall be done at times specifically approved by the Owner and Engineer in advance of any disruption of existing facilities. Also, refer to Section 23 04 00 – General Electrical Requirements.

B. Demolition Work

- 1. Coordinate all Demolition with the Xavier University so that shutdowns occur at times agreeable to the Xavier University.
- 2. The Electric Contractor shall remove certain existing air handling systems. The existing plans are available for review at the Engineer's Office and the Owner will provide access to contractors desiring to verify existing conditions. The contractor shall be responsible to verify the extent of demolition work and shall include in their bid all demolition work affecting their trade.

1.5 EXCAVATION AND BACKFILLING AND RESTORATION OF SURFACES

- A. Refer to Division 1 and Section 23 04 00.

1.6 EQUIPMENT

- A. Any and all costs associated with piping, electric, wiring, conduit, supports, pads, or other modifications to accommodate installation for manufacturer's equipment that differs from equipment layout on drawings shall be included on contractor's bid. The contractor is responsible to insure that the equipment will fit within space allocated with appropriate clearances for maintenance, operation, servicing, and code.

1.7 DUKE ENERGY INCENTIVE PROGRAM

- A. Comply with all requirements of the Duke Energy Incentive Program in order that the Xavier University will be able to obtain incentive monies from Duke Energy for this project. If Duke Energy requirements are more restrictive than the specifications, the Duke Energy requirements shall govern. A copy of the Duke Energy Incentive information for equipment is available on their web site. The contractor shall complete these forms, provide all requisite documentation, and present this information to the Xavier University for submission to Duke Energy. The incentive monies shall be solely available to the Xavier University.

1.8 QUALIFICATIONS

- A. Installer: Company specializing in performing the work of this Section with minimum three years documented experience.

1.9 LICENSES

- A. The installation of this Electrical work shall be made by Contractors and craftsmen licensed by the Governing Authorities.
- B. Obtain all permits, plan revisions, inspections, and licenses required by code authorities having jurisdiction.

1.10 FEES

- A. The Owner will obtain and pay for the building permit. The Contractor shall obtain all inspections or additional permits required by all laws, ordinances, rules, regulations or public authority having jurisdiction and obtain certificates of such inspections and permits and submit same to the Architect. The Contractor shall pay all fees, charges and other expenses in connection therein for Electric work including inspection fees, etc. associated with the building permit.

1.11 CODES, REGULATIONS AND STANDARDS

- A. Unless otherwise noted, the following latest enforced Edition shall apply to this work:

Ohio Building Code

Life Safety Code

National Fire Protection Association

National Electrical Code

Ohio Fire Code

OSHA Requirements

EPA Requirements

1.12 QUALITY ASSURANCE

- A. The Electrical Contractor shall be responsible for all costs caused by the change of equipment from the basis of design specified to other named manufacturers. The Contractor is responsible to insure that the other manufacturer named supplied equipment will fit within space allocated, with appropriate clearances for maintenance, operation, service, code requirements, etc. Any contractor utilizing a manufacturer other than basis of design shall be responsible for any additional requirements for electrical service, concrete pad size, physical space limitations, and capacities at no additional cost to the building Owner. If manufacturers are listed, no other manufactures except those listed within the Sections of this Division, that are able to comply with the contract document requirements and minimum standards of these specifications, will be acceptable.
- B. Work provided or performed by the Contractor shall be guaranteed to be replaced and made good at his own expense any defects which may develop, within one (1) year after final payment and acceptance by the building Owner, due to faulty workmanship or material, upon receipt of written notification of the defect from the building Owner.

1.13 COORDINATION DRAWINGS

- A. General:
 - 1. The HVAC Contractor shall be in charge of the coordination drawing process and shall be responsible to resolve all conflicts and settle any disputes resulting from the coordination drawing process.
 - 2. Contract drawings are diagrammatic. Included in the base bid shall be all offsets, fittings, etc. for a completed project.
 - 3. Field discrepancies shall be resolved by the field foreman. When discrepancies cannot be resolved, the signed-off coordination drawings shall be re-examined for rights.
 - 4. Documented, coordinated, dimensioned work will have precedence. Owner will not pay for rework of a particular trade. Uncoordinated work will not be tolerated.
 - 5. Coordination drawings shall be a phased process with the General Contractor, HVAC Contractor, Architect and Engineer determining the sequence of work.
 - 6. Each Contractor shall coordinate the exact location of their work with the work of other trades prior to fabrication or installation of same. Verify all dimensions and elevations. Provide additional offsets and sections of material as may be required to meet the applicable job condition requirements. Coordinate with and review all related Construction Drawings and Shop Drawings of all equipment suppliers prior to start of work.

7. It is the responsibility of the Electric Contractor to coordinate between his equipment suppliers and his temperature control subcontractor and other subcontractors as to which control devices are supplied with equipment, required wiring and voltages, and other related coordination times, so as to ensure a complete, proper, and operable installation.

B. Process

1. The HVAC Contractor shall have precedence for the allotment of available space. Ductwork rerouting for gravity drain lines may be required and shall be approved by the Engineer.
2. The HVAC Contractor shall be responsible for all trades, pre-coordinating their layouts and shop drawings with each other, including the Electric Contractor.
3. The Sheet Metal Contractor shall prepare a BIM model (Revit or Navisworks). He shall be responsible for the base drawings to be used by all other Contractors. Base drawings shall include architectural, structural and reflected ceiling plan information.
4. The Sheet Metal Contractor shall prepare ductwork drawings, at a minimum scale of 1/4" = 1'-0", in a BIM model (Revit or Navisworks). After he has finished, a CD with base drawing and ductwork shall be circulated in the following order:
 - a. Plumbing Contractor
 - b. Piping Contractor
 - c. Electrical Contractor
 - d. General Contractor
5. Each Contractor shall use the CD for preparation of their installation drawings.
6. After all trades have completed the coordination process, the General Contractor shall hold a coordination meeting to resolve conflicts. Each Contractor shall have available a drawing of his layout to be used with a light table for overlaying purposes. A representative of each Contractor, the Architect and the Engineer shall attend. All conflicts shall be resolved at the coordination meeting. The Architect and Engineer shall resolve all major conflicts as to the degree each Contractor shall alter their layout in order to allow for sufficient space for installation of the work.
7. After all work is coordinated and all conflicts resolved, each contractor shall update coordination documents in order to reflect all required minor and major modifications.
8. When all coordination is complete, the HVAC Contractor shall distribute two (2) sets of prints of the revised coordination drawings to each of the trades involved in the project, one (1) set for the Owner's Representative and one (1) set for as-built drawings.

C. HVAC Contractor:

1. All horizontal ducts shall be located and dimensioned from column center lines. Each duct shall be drawn to scale with width, depth and bottom of duct elevation clearly noted.

2. All vertical ducts shall be located from column center lines in two (2) directions. When concealed in a shaft, each vertical duct shall be shown in its total length.
3. Terminal units, heating coils, fire dampers, grilles and diffusers shall be located and dimensioned. Terminal units shall be located so as to be readily accessible from removable ceiling panel or access panel. All necessary clearances, required by codes, shall be maintained.

D. Electrical Contractor:

1. Conduits less than 1" in size are not required to be indicated on coordination drawings; however, the Electrical Contractor is responsible for routing these conduits in a manner to not cause a conflict with other trades. Conduits not indicated on coordination drawings shall be field offset to avoid all conflicts.

F. General Contractor:

1. All furrings and holes shall be clearly noted.
2. All ceiling heights shall be clearly noted.

G. Service Areas:

1. Contractors shall indicate service areas for all equipment, terminal units, etc. by shaded areas on drawings.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 EXISTING WORK

- A. Each Contractor shall locate existing site utilities, installed in previous phase, prior to beginning work. Provide adequate means of protection during work operations. Repair existing utilities damaged during work operations to the satisfaction of the utility owner and at Contractor's expense.
- B. Should uncharted or incorrectly charted piping or other utilities be encountered during work operations, notify the Engineer immediately for procedure directions. Cooperate with utility companies in maintaining active services and facilities in operation.

3.2 OPENING LOCATIONS AND CUTTING

- A. Each Contractor shall give the General Contractor locations and sizes of all openings required for the installation of new mechanical work before new walls, etc. are started.
- B. All cutting through poured concrete slabs and walls shall be done with core drills. No jack hammers will be allowed. All cutting and patching by General Contractor that is coordinated by the Electric Contractor. All cutting and patching not coordinated by the Electric Contractor with the General Contractor shall be by the Electric Contractor.

3.3 CLEANING AND PAINTING

- A. All equipment shall be kept dry and clean during the construction period.

- B. Prime and paint by General Contractor, unless otherwise noted.
- C. When all work is completed and all work has been satisfactorily tested and accepted by the Architect, mechanical equipment and other exposed surfaces shall be thoroughly cleaned.
- C. Repair marred and damaged factory painted finish with materials and procedures to match original factory finish.

3.4 EXCAVATION AND BACKFILL

- A. Provide all excavation and backfill necessary to get the work in place. Compaction and backfill materials are to be provided by this Contractor. Work to follow Division 31, Earthwork or Section 260400.

3.5 CONCRETE WORK

- A. Each Contractor shall provide concrete pads required for equipment they have supplied. See Division 3 - Cast-in-Place Concrete or Section 260400.

3.6 PROTECTION AND DAMAGE

- A. In addition to the provisions and stipulation of the General Conditions, each contractor and subcontractor shall provide various types of protection as follows:
 - 1. Protect finished floors from chips and cutting oil by the use of metal drip receiving pan and oil proof floor cover.
 - 2. Protect equipment and finished surfaces from welding and cutting splatters with baffles and splatter blankets.
 - 3. Protect equipment and finished surfaces from paint droppings, insulation adhesive and sizing droppings, etc. by use of drop cloths.
- B. All equipment shall be stored at the site with openings, bearings, etc., covered to exclude dust and moisture. All stock piled pipe shall be placed on dunnage and protected from weather and from entry of foreign material.
- C. Conduit and construction openings and excavations required for Electrical work shall be covered when work is not in progress as follows:
 - 1. Cap pipe openings with fittings or plugs.
 - 2. Cover wall and ceiling openings with plywood, or canvas covered framing.
 - 3. Cover floor openings and excavations with structural material of adequate strength to support traffic.
- D. The Owner's property and the property of other Contractors shall be scrupulously respected at all times (including damage from leaks). Provide drop cloths and visqueen or similar barriers where dust and debris is generated, to protect adjacent area.
- E. Contractor shall be held responsible for damage caused by his work or through neglect of his workmen. Repairing of damaged work shall be done by Contractor as directed by the Architect. Cost of repairs shall be paid by Contractor.

- F. The Owner reserves the right to make emergency repairs as required to keep equipment in operation without voiding the Contractor's guarantee bond not relieving the contractor of his responsibilities during the bonding period.

3.7 SPECIAL ATTENTION

- A. After all dust making procedures are performed and finishes cured, Electric Contractor shall start all air handling units in order to purge the building. Electric Contractor shall adequately protect each intake of air handling unit with disposable filter media to prevent damage to unit. Electric Contractor shall perform service maintenance; thoroughly clean all units including coils, and replace filters on all air handling units before the Owner occupies the space and at no additional cost to the Owner.

END OF SECTION 260000

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SECTION 260400 – GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL

- A. The following paragraphs are applicable to Division 26 and are complementary to other sections of specifications. Where items described in other sections of the specifications are repeated herein, it is done to call special attention to or to qualify them, but it is not intended that any part of the documents shall be assumed to be omitted if not repeated herein.
- B. Where contradictions occur between this section and Division 1, the more stringent of the two shall apply. Architect/Engineer shall decide which is most stringent.

1.2 DRAWINGS AND SPECIFICATIONS

- A. Electrical drawings are diagrammatic and indicate general arrangement of systems and work included in the contract and shall be adhered to insofar as possible. The drawings and specifications are complementary and are intended, without giving every minute detail, to cover a workable installation complete in every respect including, whether mentioned or not, all material and equipment usually furnished with such systems and/or needed to make a complete operational installation omitting only such parts as are specifically excepted.
- B. Consult drawings and details for exact location of fixtures and equipment, and where not definitely indicated, request this information in writing.
- C. The specification for this division of the work is written in sectional form for brevity and convenience in reference, without repeating in each section all applicable general clauses and/or pertinent data covered elsewhere in the specification, but it is not intended that any of the documents shall be assumed to be omitted if not repeated in this division.
- D. Where specifications are written for brevity, with incomplete sentences, the omission of words or phrases, such as "this contractor shall", "shall be", "provide", "furnish", "all", etc. are intentional and such omitted words or phrases shall be supplied by inference; unless otherwise mentioned, such clauses, lists, and/or directives indicate work to be done by this contractor for that specific branch of work.

1.3 EXISTING WORK AND/OR VERIFYING CONDITIONS

- A. The work under this contract occurs on the site of and within the existing facility. The Owner will continue to use the present building during the construction period. The work under this contract shall be scheduled and performed so as to provide a minimum of interference with the normal operation of the existing building.
- B. Before submitting a proposal, Electrical Contractors shall visit the site, and shall also carefully examine all bidding documents including those for other branches of the work, to satisfy themselves as to the nature and scope of all work to be done. Prints showing the original building architectural, structural, mechanical, and electrical work are available at the Engineer's office for contractors' review.
- C. The submission of a proposal shall be taken as evidence that such an examination has been made and difficulties, if any, noted. Later claims for labor, work, material, and equipment required for any difficulties encountered which

could have been foreseen, shall not be recognized, and all such difficulties shall be properly taken care of by this contractor at no additional expense to the Owner.

- D. The accompanying drawings and specifications illustrate and describe the existing conditions, mechanical and electrical utilities, sewers, water mains, pipes, ducts, conduits, etc. that are particularly relevant to the new work insofar as these mains are shown on existing records or evident by field inspections and tests; however, it is not the intent that these documents shall be construed to guarantee to the contractor the exact location of these items. The contractor shall verify and determine the exact location of these items in the field, and all work under this contract shall be executed to avoid conflict with or damage to existing work. The work shall be planned and executed to avoid interference, as much as possible, with the normal use of the existing building.
- E. All work involving hazards to persons shall be suitably barricaded and provided with warning lights or signs, as required.
- F. Where necessary for the performance of the contract, existing work shall be cut, altered, removed, or temporarily removed and replaced. Work that is altered or replaced shall match similar existing work and said work shall be performed by trade applicable to the work; if said work is NOT shown or noted the Drawings relating to applicable trade, cost shall be paid by contractor requiring said work. However, unless otherwise provided by the drawings or specifications, no structural members shall be cut or altered without authorization of the Architect and Engineer. Work remaining in place, which is damaged or defaced by reason of work done under this contract, shall be restored in kind equal to its condition at the time of award of the contract by applicable trade as hereinbefore specified.
- G. Existing work shall not be disturbed further than necessary for proper installation of new work. New work to be connected or made integral with existing work shall be properly erected to secure solidity and be continuous in finish. Such new work in extension of existing work shall correspond in all respects with that to which it connects, or similar existing sound work, unless otherwise specified.

1.4 ALTERATIONS TO EXISTING WORK

- A. Alterations and additions to existing work shall include the requisite dismantling of the old equipment, rigging, wrecking, hauling, protection of permanent equipment and the building structures, and cleaning up. Care shall be exercised to keep dust and dirt to a minimum and to confine it to the area where the removal work is being performed. All debris shall be promptly removed.
- B. If asbestos insulation is encountered on any existing wiring which is to be removed or remodeled, contractor shall immediately notify Owner of the existence of asbestos and Owner will arrange proper removal of same without cost to contractor.
- C. Unless otherwise noted, remove all other existing equipment and conduit, wires, boxes, etc. which will not be reused in the final arrangement. Unless otherwise noted, all items which will be removed by this contractor and not reused shall become the property of the contractor and shall be promptly removed from the site by him.

1.5 EXISTING MECHANICAL AND/OR ELECTRICAL FACILITIES

- A. Where existing mechanical and electrical facilities and/or service lines occur in the area of the work and such facilities or lines are to be abandoned or changed, the contractor for the branch of work or trade involved shall cut off and properly cap the old lines, so as not to interfere with the new construction work. If any portions of such lines are required for the operation of the existing building the lines shall be altered and relocated to clear new construction and shall also be restored into service to provide continued operation of the existing building.

1.6 INTERRUPTION OF SERVICES

- A. The existing facility will be occupied and will remain in operation throughout the period that this work is being performed, and certain new work will be performed during this period. Unscheduled interruptions of the facility will not be tolerated. The contractor shall exercise extreme caution, shall thoroughly inform his workmen and subcontractors of the critical nature of this work, and shall continually review the work procedure being followed in order to prevent accidental interruption of service. Before performing any act which could result in interruption of service, the contractor shall notify the Owner and Engineer of the hazards involved and the contractor shall proceed in a manner and at a time specifically approved by the Owner and Engineer.
- B. All work necessitating the temporary turning off or shutting down the operation of existing mechanical and/or electrical facilities shall be done at times specifically approved by the Owner in advance of any disruption of existing facilities.

1.7 MATERIALS AND EQUIPMENT

- A. All materials and equipment entering into the work shall be approved by the Architect and Engineer, and must be new, without defects, and of the sizes and capacities shown on the drawings or hereinafter specified. All manufactured materials or equipment shall bear the identification mark of the manufacturer or, if required by the Architect and Engineer, shall be certified by an approved testing laboratory. All equipment shall operate within the manufacturer's range of speeds, guaranteed capacities, performance, etc. as indicated by the manufacturer's latest catalog and/or engineering data, shall be of proper size and dimension for the allocated space, and shall be placed in the space allocated in the proper construction sequence. Special consideration will be given to equipment which has been in successful field use or similar applications for at least three (3) years (exclusive of field tests), and to equipment which has an extended guarantee period in lieu of long use period. This contractor shall submit with his bid complete data on equipment he proposes to use; failure to so submit, or to meet these requirements fully and those of the specifications, shall be grounds for rejecting the items.
- B. All electrical materials, apparatus, and equipment shall be new, of the make and characteristics specified, shall conform to NEMA standards, and shall be designed to comply with and be installed in accordance with the latest rules and regulations of the National Electrical Code, and all of the legally constituted public authorities having local jurisdiction. Upon completion of the work, furnish a certificate of approved inspection from an approved electrical insurance inspector. Verify the exact voltage and current characteristics at the building before ordering motors or similar equipment.
- C. Conduct such tests and adjustment of equipment as specified or necessary to verify performance requirements. Submit data taken during such tests.

1.8 QUIET OPERATION

- A. The work shall be installed in such a manner that under all conditions of load it shall operate without sound or vibration which is objectionable in the occupied spaces, in the opinion of the Architect and Engineer.
- B. In case of moving machinery, sound or vibration noticeable outside of the room in which it is installed or annoyingly noticeable inside its own room will be considered objectionable. Sound or vibration considered objectionable shall be corrected by the contractor.

1.9 PROTECTION

- A. In performing this contract, safeguard workmen and the public and protect the work and equipment until final completion and acceptance. After delivery and before and after installation, protect work against theft, injury, or damage. Carefully store material and equipment received on site which are not immediately installed. Close open

ends of work with temporary covers or plugs during construction to prevent entry of obstructing materials. Protect related or adjacent work and the material of the other trades or the Owner from damage that might be caused by this work and make good any damage thus caused. Provide all safeguards, scaffolding, drop cloths, etc. as required.

- B. No welding or soldering shall be done near combustible materials of any kind; all adjoining work, finished surfaces, glass, etc. shall be protected from flames, sparks, hot metal, etc. by metal guards or approved noncombustible drop cloths or barriers.
- C. Each contractor shall replace any items or portions thereof wherever removed or damaged, in a manner equal to the original construction and finish, or where directed by the Architect and Engineer, contractor shall pay other trades to perform this work.
- D. All mechanical and electrical equipment with a factory finish shall be protected during construction and must be free of dust, dirt, cement splatters, etc. when building is turned over to the Owner. Dents and marred finishes are to be repaired to the satisfaction of the Architect and Engineer, or a replacement furnished where necessary.

1.10 EXECUTION OF WORK

- A. Promptly upon award of contracts, the Electrical subcontractor shall confer with the General Contractor and Engineer and the other subcontractors to prepare a time schedule for completion of the work. The electrical work shall be performed and coordinated with the program of the General Contractor and the other subcontractors. Each subcontractor shall proceed diligently with the work and shall cooperate with the General Contractor and the other subcontractors to maintain the approved project construction and progress schedule to the best of his ability and as conditions permit.

1.11 GENERAL SUPERVISION AND INSTALLATION OF WORK

- A. Each contractor shall at all times give the work his best skill and attention, including adequate construction supervision over his work, employees, and sub-contractors, and he shall fully cooperate with and confer with the Architect and Engineer and other contractors so that the best possible installation shall be obtained. Exact locations and relations are to be determined in the field, subject to the approval of the Architect and Engineer, and with preference to the dimensioned drawings and approved shop and setting drawings.
- B. Unless otherwise shown, conduits, etc. shall be exposed.
- C. Install conduits, etc. in a neat and workmanlike manner, close to walls, generally as high as possible, true and square to the building, utilizing standard practices, and properly graded for correct functioning of the system involved; multiple lines in close proximity shall be coordinated and neatly grouped. Install work in proper construction sequence and arranged so as to be readily accessible for operation, maintenance, and repair; minor deviations from drawings may be made to accomplish this, but changes of magnitude or which involve extra cost shall not be made without approval. All fixtures, outlets, etc. shall truly center with the adjacent architectural finish. All work, both exposed and concealed, shall meet the approval of the Architect and Engineer regarding neatness of appearance, location, and practicability of installation. The Architect and Engineer reserve the right to direct the removal and replacement of any item which, in his opinion, does not present an orderly and reasonably neat and workmanlike appearance.
- D. Each contractor shall cooperate with the General Contractor in the preparation of the "Coordination Drawings". The contractor shall familiarize himself with the work of the other contractors, shall lay out his work to meet conditions at the building, shall give freedom to and prevent conflict with the work of other contractors, and shall make reasonable modification in locations or arrangement from those indicated on the drawings if required to avoid conflicts or to conform to tile, wood, marble, or other architectural finish. From time to time as the work progresses, each contractor shall examine the work installed by others, insofar as it may affect his work, and he shall, before

proceeding with the work, notify the Architect and Engineer in writing, and shall not proceed until directed by the Architect and Engineer, if any condition exists which prevents the successful installation of his own work.

- E. If the contractor places any work in violation of any of the above mentioned requirements, and conflicting or unworkmanlike conditions result, he shall, without additional charge, remove and reinstall or satisfactorily readjust such portions of his work as may be necessary and as the Architect and Engineer may direct. The Architect's and Engineer's decision regarding such conditions shall be final.

1.12 ENGINEER'S OBSERVATION

- A. Periodic observation of the work by the Engineer is only for the express purpose of verifying compliance by the contractor with the contract documents to the best of his knowledge. Such engineering observations and services rendered by the Engineer or his representatives shall not be construed as the supervising of construction; nor the assuming by the Engineer of the duties and responsibility of the contractors; nor making the Engineer responsible for providing a safe place or procedure for the performance of the work or for the contractors' employees or for sub-contractors.

1.13 EXCAVATION AND BACKFILLING OF TRENCHES, ETC.

- A. Unless otherwise specified, each Electrical Contractor shall do all excavation of trenches for conduits, etc. in connection with his work, and after his work is in place and inspected by the Architect and Engineer and Civil Authorities, he shall backfill in layers of not to exceed six inches (6") in depth, thoroughly moistened, thoroughly rammed, tamped, and compacted to a density at least equal to the surrounding earth to minimize after settlement. If, in the opinion of the Architect or Engineer, the excavated material is unsuitable for backfilling, the contractor shall backfill with bank run gravel well compacted. Top of backfill or trench surface shall be level with adjoining ground or surface; furnish additional material if required to fill trenches. All surplus earth shall be moved by this contractor and disposed of as directed by the Architect or Engineer. Compact backfill in trenches within building lines the same as specified in architectural branches.
- B. Any sheet piling or shoring or pumping necessary shall be done by this contractor at his own expense and all trenches shall be dug in a careful manner, with bottoms properly pitched to insure perfect drainage and to provide uniform bearing and support for each section of pipe on undisturbed soil along its entire length, except where it is necessary for the proper sealing of joints. These trenches shall be not less than 12" wider, nor more than 16" wider, than the outside diameter of the pipe or conduit to be laid therein; this requirement applies to the width at and below the level of the top of the pipe or conduit; the width above that level may be wider for proper sheeting and bracing and the proper installation of the work. Shoring, bracing, barricades, etc. shall be provided to protect the workmen and/or public amply.
- C. Unless otherwise approved, the following minimum cover shall be provided above the top of underground pipes outside the buildings: Water lines, 4'-0"; gas lines, 3'-0"; electrical and telephone lines, 2'-0" above concrete encasement; sewers, refer to elevations on plans.
- D. Whenever wet or otherwise unstable soil, that is incapable of properly supporting the pipe as determined by the Architect or Engineer, is encountered in the trench bottom, such soil shall be removed to a depth required and for the length designated by the Architect or Engineer, and the trench backfilled to trench bottom grade with coarse sand, fine gravel, or other suitable materials, properly compacted.
- E. Excavation near or under building footings shall be backfilled with concrete installed under the direction of the Architect or Engineer.
- F. Where contractor elects to have any excavation work performed by a subcontractor, subcontractor must be approved by the Owner prior to commencing any work.

G. Construction Fence

1. Refer to Division 1.

1.14 RESTORATION OF SURFACES AND CONCRETE WORK

- A. Unless otherwise specified, all new concrete work for parking lots, driveways, pads, etc. shall be provided by the General Contractor. All surfaces such as concrete floors, walls, paving, sidewalks, roof deck, or other surfaces disturbed in the execution of work by this subcontractor, and which remain in use, shall be restored in kind by this subcontractor, or he shall pay the cost of such work.
- B. Where each contractor has performed excavation work, each contractor shall backfill as hereinbefore specified in Paragraph 13.
- C. In Landscaped Areas, such as grass or plantings, the final 6" of backfilling, grading, seeding, mulching, and planting shall be performed by a qualified, competent Landscaping Contractor. The Contractor shall include in his bid the cost of such landscaping services and shall warrant same as described under Paragraph 24.
1. This final 6" of backfill provided by the approved Landscaping Contractor shall consist of top soil complying with Ohio DOT 653.02; ph 6.0 to 7.0 or adjusted within these limits, raked to a uniform fineness and free of rock or stones 1" or greater in any dimension.
 2. Where grass has been disturbed, the Landscape Contractor shall apply 8/32/16 organic fertilizer at rate of 1 lb. per 5 square yards and seed with 90-95% pure, 85% (minimum) germination seed of a mixture of 20% Rye grass, 40% creeping red fescue, and 40% Kentucky blue grass at a rate of 7 lbs. per 1000 square feet. Cover seeded areas with clean, weed free straw.
 3. If shrubbery and plantings must be disturbed, the Landscaping Contractor shall either remove, maintain, and reinstall said plantings or the Landscape Contractor shall furnish healthy new shrubbery and plantings similar in kind to that which was removed. In either case, the Landscape Contractor shall fertilize and provide mulch around said plants.
- D. In Blacktop Paved Areas, the work shall be performed by a qualified, competent Blacktop Contractor; bids shall be based on and work shall comply with the following:
1. All materials and workmanship shall comply with the latest edition of the State of Ohio Department of Transportation Construction and Material Specification.
 2. Paved areas shall match existing slopes and shall be without dips or low spots. All seams in paving to be flush and tight.
 3. Begin rolling when mixture will bear roller weight without excessive displacement. Repair surface defects with hot material as rolling progresses. Cut out and patch defective areas and roll to blend with adjacent satisfactory paving. Continue rolling until maximum density is attained and roller marks eliminated.
 4. Protect newly placed material from traffic until mixture has cooled and attained its maximum degree of hardness.
 5. Remove and replace mixtures that become contaminated with foreign materials and defective areas and fill with fresh, hot mix properly compacted. Remove deficient areas for full depth of course. Cut sides perpendicular and parallel to direction of traffic with edges vertical. Apply tack coat before placing new mixture.

6. Thickness of Paving shall be as follows:
 - a. Base: ODOT-301, compacted thickness 9".
 - b. Prime Coat (over base): ODOT-408, 3.0 Gallons/Square Yard.
 - c. Wearing Course: ODOT-404, two separate 1-1/2" layers each compacted; total compacted thickness 3".
 - d. Tack-coat: ODOT-407, 0.20 Gallons/Square Yard.
 - e. Restore all parking space lines and space numbers using materials in accordance with Ohio Department of Transportation Section 621 - Pavement Marking.
- E. Concrete Work, shall be performed by a qualified, competent, Concrete Contractor, and work shall comply with the following:
 1. Sidewalks shall be concrete, Class C, unreinforced, complying with ODOT 608. Width and finish shall match existing adjacent sidewalks. Sidewalks shall be the same depth as the existing adjacent sidewalks or 7" deep whichever is greater.
 2. All other concrete for parking lots, driveways, and pads shall be 4000 PSI compressive strength concrete with reinforcing steel. Thickness of concrete for parking lots and driveways shall be not less than 7" thick. Reinforcing steel shall be 6" x 6" 58 pound welded wire fabric (WWF) top and bottom. All welded wire fabric shall be in flat sheets, not rolls.

1.15 SLEEVES, CUTTING, PATCHING, CLEANING, WATERPROOFING, ETC.

- A. Provide and accurately set frames and Schedule 40 steel pipe sleeves for required openings in new work to minimize cutting. Perform all cutting, patching, etc. required to install the work. Use approved power operated boring machine for small holes wherever practical. Remove all rubbish incidental to the work. Where any work pierces waterproofing, provide all necessary sleeves, caulking, and flashing required to make openings absolutely watertight.
- B. Refer to the ACI Code 381.71, Section 6.3 for limitations and requirements for penetrations and openings.

1.16 PATENTS

- A. The contractor shall defend and guarantee the Owner against any expense, claims, litigation, etc. occasioned by the use in this work of any materials, devices, etc. covered by patents not owned by this contractor, or of which he is not a licensed user.

1.17 CONTEMPLATED WORK

- A. The drawings and specifications for the mechanical and electrical portion of this project have been prepared by Motz Consulting Engineers, Inc., doing business as Motz Engineering.
- B. The various items of work necessary for completion of this work are hereinafter specified under the respective section headings or shown on accompanying drawings, and shall be included in any contract or contracts made for

completion of respective divisions of the work. Such contracts shall also include necessary details reasonably incidental to the proper execution and completion of such work.

1.18 MOVING MATERIALS

- A. If it becomes necessary at any time during the progress of this work to move materials which have been temporarily located and which are to enter into the final construction, the contractor furnishing said materials shall, when so directed by the Engineer, move them or cause them to be moved. Cost of such moving shall be included in the contract price.

1.19 ACCIDENT PREVENTION

- A. Precaution shall be exercised at all times for the protection of persons and property. The safety provisions of applicable law, building, and construction codes shall be observed. Machinery, equipment, and other hazards shall be guarded in accordance with safety provisions of the "Manual of Accident Prevention in Construction" published by Associated General Contractors of America to the extent that such provisions are not inconsistent with applicable law or regulations.

1.20 TOOLS AND MATERIALS

- A. Tools and materials shall be stored on the premises at locations designated by the Owner.

1.21 PROPERTY PROTECTION

- A. All hoisting shall be done with proper tag lines and buffers to prevent damage to the sides of the building. Where it is necessary to hoist materials to the roof, the parapets at top of the building and the roof where materials are landed from hoists shall be protected with heavy wood covers. Parapet protection shall be placed on both sides and top, and shall extend far enough on either side of landing point to insure adequate cover. The roof, from the landing point at parapet to final location of material, shall be adequately protected by planks laid side by side on roofing and spiked together on outside edges with planks running at right angles to main planking. The roof shall be adequately protected against leaks at all times.
- B. Where hoists are erected on the roof for hoisting material up the side of the building, the roof shall be adequately protected against abrasion or other damage. Materials stored on the roof shall be placed on planks or other protection approved by the Engineer and shall be placed only at locations approved by the Engineer.
- C. If hoisted materials are taken through windows, the jams, head, and sill shall be adequately protected with wood planking or proper buffers.
- D. Any work, equipment, or property damaged during construction of this project and due to operations under this contract shall be repaired or replaced by this contractor, without additional cost to the Owner. Upon completion of the work, the contractor shall remove all protections herein specified.

1.22 REMOVAL OF RUBBISH

- A. It shall be each contractor's duty to keep the building and surrounding premises clean, free from rubbish of every description. No rubbish, crating materials, packing, or dirt shall be allowed to accumulate at any time, but shall be removed at once and hauled away.

- B. Each trade shall be responsible for its own tools and materials during the periods of rubbish removal but contractors shall use reasonable care in removal of rubbish to protect the tools and materials of others against loss or damage. The Owner reserves the right, in the event that removal of rubbish is not promptly and properly carried out by the Contractors to have rubbish removed and to charge the cost of its removal to the contractor.
- C. Also, refer to Division 1.

1.23 MATERIAL SAFETY DATA SHEETS (MSDS)

- A. The contractor shall obtain and maintain on-site during the course of the project the Material Safety Data Sheets (MSDS's) for all chemicals or products containing chemicals that may be considered toxic or hazardous. The MSDS's are to be forwarded to the Office of Environmental Health and Safety upon completion of the project.

1.24 INSTRUCTION OF PERSONNEL

- A. The Electrical Subcontractor shall provide free on site instruction in the proper use of installed equipment to designated representatives of the Owner, sufficient to ensure safe, secure, efficient, non-failing utilization, and operation of systems. This instruction shall include the following:
 - 1. One Site Training: Provide a minimum of 24 hours of training for owner's staff. Submit a syllabus to the Engineer prior to the first session.
 - 2. Support: Provide a minimum of 16 hours of support either on site or by telephone to answer operations questions.

PART 2 – (NOT USED)

PART 3 – (NOT USED)

END OF SECTION 260400

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SECTION 260500 – GENERAL ELECTRICAL PROVISIONS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions, General Requirements, Division 1 Specifications, apply to this Section.

1.2 REFERENCE TO CONDITIONS OF THE CONTRACT

- A. The Conditions of the Contract General, Supplementary and other Conditions and Divisions 1 through 31 and General Requirements, apply to the work specified in Division “26” and “28”. Unless the specifications contain statements which are more definitive or more restrictive than those contained in the Conditions of the Contract, the specifications shall not be interpreted as waiving or overruling any requirements expressed in the Conditions of the Contract.
- B. No claim or additional compensation shall be entertained on behalf of or paid on account of failure to be informed of the above conditions and requirements.
- C. Should a bidder find discrepancies in or omissions from the drawings or specifications, or should he be in doubt as to their meaning, he should at once notify the Associate who shall send written instructions to bidders. If these are ignored by the Contractor, he shall be responsible for furnishing the proper or workable equipment as necessary.
- D. Before submitting a bid, bidders shall be held responsible to have visited the site of work, attend the Pre-Bid Meeting, and fully inform themselves as to existing conditions and limitations, including rules, rates and fringe benefits, travel pay, affiliation fees and transportation expense prevailing in the local labor market, and no allowance shall subsequently be made on behalf of the bidder by reason of any error on his part.
- E. Carefully examine the architectural, structural, heating, ventilating and air conditioning, plumbing and any other relevant contract documents. If any discrepancies occur within Contract documents, report such discrepancies to the Associate in writing and obtain written instructions as to the manner in which to proceed. No departures from the contract documents shall be made without prior written approval of the Associate.
- F. Obtain any additional reference documents and/or information required for installation prior to installing equipment. Coordinate work with other trades making minor adjustments as required. Wiring or conduit layouts are schematic based and exact locations shall be determined by structural or other restricting conditions.
- G. Minor details not usually shown or specified but necessary for proper installation and operation shall be provided in the Electrical Contractors estimate, the same as if herein specified or otherwise shown.
- H. Coordination with the Utility servicing this facility including following and policies of the utility company shall be included in this bid. Where material and installation is deemed the responsibility of the Electrical Contractor by the Utility Company, such work shall be included within his bid.
- I. Electrical Contractor bid submission shall give written notice to the Architect of record any materials or apparatus believed inadequate, in violation of laws, ordinances, rules, standard installation practices and any necessary item required or work omitted. In the absence of such written notice, it is mutually agreed that the Electrical Contractor has included the cost associated of all required item in his proposal and that he will be responsible for the approved satisfactory functioning of the entire system without extra cost compensation.

1.3 WORK INCLUDED

- A. Provide and install a complete and operating electrical installation in accordance with these specifications and accompanying contract documents. This shall include required labor, material, apparatus and supervision.
- B. Without limiting or restricting the volume of work and solely for convenience, the work to be performed will, in general, comprise the following:
 - 1. Demolition of selected electric feeders, branch circuits and supporting equipment. Coordination of demolition work with other trades.
 - 2. Provide new feeder and branch circuit wiring including overload and disconnecting means. Alterations to existing wiring systems per plans.
 - 3. Provide wiring devices, covers, multi-gang plates and supporting back boxes and/or equipment.
 - 4. Provide emergency lighting systems, with battery back-up and related equipment. Provide light fixtures, retrofits, new lamps, supports, controls, wiring and related branch circuits.
 - 5. Support and provide wiring of equipment and final connections of equipment furnished by others.
 - 6. Grounding and bonding of equipment.
 - 7. Modifications to or replacement of existing systems such as; Fire alarm, telephone, public address and security systems.
 - 8. Coordination, handling, installation and test of Owner furnished equipment or materials.
 - 9. Required material and labor necessary to complete project scope as indicated within project Contract documents.
 - 10. Temporary services: construction lighting and power.
 - 11. Fire alarm devices alterations including new device installation such as detectors, door holds, notification appliances, activation appliances, field information gathering, field required documentation, system programming alterations, testing, and coordination.
 - 12. Phasing: The Electrical Contractor and any subcontractors thereof, shall conform project related electrical work to project phasing requirements as outlined in Division 1. Electrical work shall be coordinated and scheduled to provide feeders, branch circuits or equipment installation in advance (where applicable) to the next phase sequence. The intent is to minimize rework and removal of finished ceilings by extending temporarily capped raceways into the next defined phasing area. This Contractor shall provide required labor and material to effectively meet project-phasing requirements.
- C. Items of labor, material, and equipment not specified in detail or shown within Contract documents, but incidental to or necessary for the complete installation and proper operation of the several branches of work and described herein, or reasonably implied in connection herewith, shall be furnished as if called for in detail by the specifications or Contract documents. This includes electrical work associated with mechanical and plumbing work whether indicated on electrical drawings or not.
- D. This contractor is advised to carefully coordinate the delivery of large, awkward, heavy equipment, material or relevant items. Delivery limitations may require modifications, supporting means or structural modifications in order to set equipment or components. This contractor shall be responsible for all calculations, material, labor, equipment, machinery, deliveries, transportation or safety related equipment required for equipment such as but not limited to: transformers, switchgear, generator, site lighting, disconnects, staging materials, panelboards etc.
- E. Electrical Contractor shall provide raceways, fittings, supports, feeders, branch circuits, overload/short circuit protection, relays, starters, terminals and related accessories to complete his work including installation and termination of items, equipment or controls furnished by other contractors unless specifically stated otherwise.

- F. It is the responsibility of the Electrical Contractor to verify proper motor rotation and sizing of motor overload protection is in compliance with NEC and equipment manufacturer.

1.4 WORK NOT INCLUDED

- A. The following items of Electrical Construction are not included in this contract:
1. Low voltage wiring of certain systems or devices shall be done by the respective Contractor such as temperature control wiring, interlock wiring and related control devices for HVAC equipment unless noted or otherwise. Raceways shall be provided by the Electrical Contractor.
 2. Certain motors and equipment shall be provided by others, complete with motor and built-in or separate controllers as covered by such contracts such as packaged HVAC or plumbing equipment. The Electrical contractor shall provide feeders, branch circuits and/or disconnecting means as called for within the Contract documents.

1.5 DEFINITIONS AND ABBREVIATIONS

- A. Definitions
1. "Furnish" shall mean supply and deliver to project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.
 2. "Install" shall be used to describe operations at project site including unloading, packing, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protection, cleaning, and similar operations, as applicable in each instance.
 3. "Installer" shall mean a company or individual specializing in performing work meeting the requirements of their trade with minimum of three (3) years of experience.
 4. "Provide" shall mean furnish and install, complete and ready for intended use, as applicable in each instance.
 5. "Directed" shall mean as directed by Owner or its Representative prior to installation of equipment.
 6. "Indicated" shall mean "indicated on Contract Documents".
 7. "Shown" shall mean "shown on Contract Documents".
 8. "Section" shall mean one of the Specification Sections.
 9. "Division" shall mean one of the Specification Divisions.
 10. "Article" shall mean one of the numbered paragraphs of the Specification Section.
 11. "Work" or "Electrical Work" herein includes products, labor, equipment, tools, appliances, transportation and related items, directly or indirectly required to complete the specified and/or indicated electrical installation.
 12. "Code" shall mean any and all regulations and requirements of regulatory bodies, public or private, having jurisdiction over the work involved.
 13. "Product" used in Division 26, 27 and 28 means material, equipment, machinery, and/or appliances directly or indirectly required to complete the specified and/or indicated Electrical Work.
 14. "Standard Product" shall mean a manufactured product, illustrated and/or described in catalogs or brochures, which are in general distribution prior to the date of issue of construction documents for bidding. Products shall generally be identified by means of a specific catalog number and manufacturer's name.
 15. "Wiring" shall mean fittings, conduits, wires, junction boxes, connections to equipment, splices, and other accessories required to complete the work.
 16. Abbreviations and Symbols: See lists on drawings.

17. "This Contractor" shall mean the Contractor responsible for Divisions 26, 27 and 28 work.
18. Contract Documents: drawings, specifications, manufacturer's specification/data sheets, bid forms, addendum, and change orders.
19. Whenever the phrases "approved by the Associate or Owner's Representative," "approved equivalent," or "equivalent to" appear in these specifications, they shall be interpreted as meaning "as recommended by the Associate and approved by the Authority."

B. Reference to the latest editions of codes and standards shall mean:

Reference Definition

NEC	National Electrical Code
ASTM	American Society for Testing Materials
NEMA	National Electrical Manufacturers Association
ANSI	American National Standards Institute
FS	Federal Specification, US Government
CS	Commercial Standards issued by US Department of Commerce
NESC	National Electrical Safety Code
NETA	National Electrical Testing Association
ADA	Americans with Disabilities Act
OBC	Ohio Building Code
NFPA	National Fire Protection Association
Owner	Owner / Owner's Representative

1.6 REGULATIONS

- A. Electrical work, equipment, and materials furnished and installed under this contract shall conform to the requirements of the latest edition of the National Electrical Code, the National Fire Protection Association and any other governmental or local authorities having jurisdiction. Pay any fees required for the installation of this Division work. Certificates of approval shall be obtained in duplicate from any department or agency issuing same, and shall be turned over to OWNER or its representative at the completion of the work.
- B. Provide any labor, materials, services, apparatus, CAD drawings and documents required to comply with applicable laws, ordinances, rules and regulations, whether or not shown.
- C. Obtain certificates of inspection and approval from authorities having jurisdiction and deliver same to OWNER as a prerequisite for final acceptance of the work. Provide record copies of permit applications, permits and other items for which certification are indicated.

1.7 SPECIAL ENGINEERING SERVICES

- A. In the instance of complex or specialized electrical systems such as fire alarm, security, telecommunication or similar systems; the installation, final connections and testing of such systems shall be made under the direct supervision of qualified authorized service engineers who shall be in the employ of the respective equipment manufacturer. Provide OWNER with copies of instruction manuals and booklets for each

system and piece of equipment installed. Provide any additional instructions over and above that listed above in the care, adjustment and operation of parts of the electrical systems.

- B. Pay any and all expenses incurred by these equipment manufacturers' representatives.

1.8 SUBMITTALS

- A. Shop drawings, product data, and samples shall be submitted to the Associate for approval. Submit a minimum of (6) sets (or equivalent documentation in PDF format) of shop drawings and related specifications to the Associate in a bound set included with letter of transmittal.
1. Electrical Contractor must first review content for project specification compliance prior to submission. Drawings and specifications shall bear the Electrical Contractor's approval stamp indicating specification compliance. Sets received without Electrical Contractors approval stamp will not be reviewed.
 2. Shop drawings shall be new drawings, and not reproductions or tracings of the Contract Documents. In preparing shop drawings, establish lines and levels for the work specified, and check the drawings to avoid interference with structural features and other work. Immediately call to the attention of the Architect any interference for clarification in writing.
 3. Manufacturer's literature and data sheets shall be submitted indicating the necessary installation dimensions, weights, materials, and performance information. Each piece of literature shall be identified with the specific specification number, paragraph, and equipment schedule identification.
 4. Engineer's review of Manufacturer documents or specifications shall not relieve the contractor from responsibility of errors or omissions in such submittals, schedules, drawings or deviations form contract documents.
 5. Layout and detail drawings shall be submitted in the form of legible sepia reproducible and paper prints. Manufacturer's drawings shall be standard drawings. Equipment shop drawings shall show specific data and other special features required for review consideration.
 6. Equipment shop drawings (8-1/2 by 11 inch sheets) shall be bound together in sets, in loose leaf binders, and shall be indexed in accordance with Specification Section. Additional shop drawings may be submitted at a later date for insertion therein, and the original submittal shall note which shop drawings shall be submitted later. Marked-up catalogs are not acceptable, and shall be rejected.
 7. Materials and equipment shop drawings shall be submitted within 30 calendar days of Contract receipt.
 8. Manufacturers' instruction manuals shall be submitted together with shop drawings. Furnish instruction manuals and parts listed for each piece of electrical equipment, on 8-1/2 by 11 inch sheets, or catalogs, suitable for loose leaf side binding, packaged separately, and clearly identified. Instructions shall include information pertaining to installation, operation, and maintenance of equipment as applicable. Each piece of literature shall be clearly identified with the specific job equipment identification. Literature shall be factory printed and not reproduced copies.
 9. Any characteristic of any piece of equipment which deviates from the characteristics of the equipment specified shall be hi-lighted and circled in red.
- B. Submit manufacturers' data, and/or shop drawings of the following:
1. Distribution panels, branch panelboards, and related equipment.
 2. Emergency and safety related equipment.
 3. Transformers.
 4. Lighting Fixtures with ballast data.
 5. Wiring devices.
 6. Automatic transfer switches.

7. Lighting controls devices such as switches, contactors, motion, occupancy sensors and relevant control sensors.
8. Surge protection and waveform corrector equipment.
9. Disconnect switches, motor starters, and controls supplied by the Electrical Contractor.

1.9 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. After final tests and adjustments have been completed, furnish the services of qualified personnel to fully instruct the OWNER Maintenance representative in the operation and maintenance procedures for equipment installed. Operation and maintenance instructions for major items of equipment shall be directly supervised by the equipment manufacturer's representative. Supply qualified personnel to operate equipment for sufficient length of time as required to meet governing authorities' operation and performance tests and as required to assure that OWNER representatives are properly qualified to take over operation and maintenance procedures.
 1. Notify the Associate, OWNER representatives and equipment manufacturers' representatives, by letter, as to the time and date of operating and maintenance instruction periods at least one week prior to conducting same.
 2. Forward to the Associate the signatures of all present for the instruction periods.
- B. Furnish three (3) copies of recommended equipment operation and maintenance procedures manuals as specified herein, assembled and bound together in 8-1/2 by 11 inch three-ring binders. The ring binders shall be submitted to the Associate in accordance with procedures established for shop drawing submittals.
 1. The operation and maintenance procedures manuals shall include the following:
 - a. Project Title
 - b. Associate's Name and Address
 - c. Date Submitted
 - d. Contractor's Name and Address
 - e. Index (in alphabetical order, with page numbers)
 - f. General Description of Each System
 - g. Parts List, identifying the various parts of equipment for repair and replacement purposes.
 - h. List of spares recommended for normal service requirements.
 - i. Operating instructions outlining step-by-step procedures required for system start-up and operation. The instructions shall include the manufacturer's name, model number, service manual, and brief description of each piece of equipment and its basic operating features.
 - j. Maintenance instructions describing routine maintenance and lubrication procedures and schedules, and simplified diagrams which illustrate the systems as installed.
 - k. Wiring and control diagrams for each piece of equipment, showing "as installed" conditions.

1.10 SINGULAR NUMBER

- A. References made to any item in the singular number shall apply equally to as many identical items that the work may require.

1.11 PROTECTION OF SERVICES

- A. Repair, replace and maintain in service any new or existing utilities, facilities or services (underground, overhead, interior or exterior) damaged, broken or otherwise rendered inoperative during the course of construction. The method used in repairing, replacing or maintaining the services shall be approved OWNER and Associate. OWNER reserves the right to make emergency repairs as required to keep equipment in operation without voiding the Contractor's guarantee bond not relieving the contractor of his responsibilities during bond period.
- B. OWNER's property and the property of other trades shall be scrupulously respected at all times include damage from leaks. This contractor shall provide drop cloths or similar barriers where dust or debris is generated protecting adjacent area.
- C. This contractor shall be held responsible for damages caused by his work or through neglect of his workman or subcontractors. Repairing of damages shall be done in accordance by OWNER or its representative. Costs associated with repairs shall be paid by this contractor.

1.12 PROTECTION OF FLOORS, EQUIPMENT AND PERSONNEL

- A. Protect flooring from damage during the construction period. Provide plywood or similar material under equipment or materials stored on floors, and in areas where construction may damage the floor surfaces. Replace floor surfaces (including sealer) damaged during the construction.
- B. In addition to the provisions and stipulation of the General Conditions, each contractor and subcontractor of shall provide various types of protection as follows:
 - 1. Protect finish floors from chips and cutting oil by the use of metal drip receiving pan and oil proof floor coverings.
 - 2. Protect equipment and finish surfaces from welding and cutting splatters with baffles and splatter blankets.
 - 3. Protect equipment and finished surfaces from paint droppings, insulation adhesives, grout, fire proofing and other related non-finished material.
- C. All equipment shall be stored at the site with openings, bearings, etc., covered to exclude dust, moisture or foreign debris from entering.
- D. Construction openings, trip hazards and unsafe conditions created by this contractor shall be scrupulously inspected for personnel safety and protection of property with strict compliance of OSHA work and construction practices.
- E. Conduit and excavations required for electric work shall be covered when work is not in progress such as capping conduit openings, cover wall or floor openings with material of adequate strength supporting construction traffic, safety warning tape, warning lights and signs.

1.13 TEMPORARY LIGHT AND POWER SERVICES

- A. Refer to the Division 1, General Requirements, of these specifications to determine responsibility for temporary lights, power, water and heat.
- B. The Electrical Contractor is responsible for all temporary power and lighting requirements throughout construction. The Electrical Contractor shall review all associated phasing plans and schedules and provide any and all equipment, either temporary or permanent, required to maintain or provide temporary power and lighting to all areas of this facility, throughout the construction process.

- C. In addition to minimal temporary lighting and power needed for construction operations, occupied areas throughout construction shall be provided with temporary power and lighting services that meet or exceed the existing services that currently serve these areas. Power interruptions to such areas shall be kept minimal and be scheduled 48 hours prior to alterations of service.
- D. The electrical documents indicate the final arrangement for the power/lighting/communication/ signal/data systems and do not reflect equipment, devices, etc., needed to provide the required temporary power and lighting services.
- E. At the completion of this project, all temporary lighting, temporary receptacles, and temporary wiring shall be removed in their entirety.
- F. Waste material generated by this contractor or relating to his work shall be properly disposed of in accordance to local, state and federal guidelines or requirements.

1.14 SUBSTITUTIONS

- A. It is the intent of these specifications that wherever a manufacturer or product is specified, and the term "or approved equivalent" is used, the substituted item must conform in respects to the specified item. Consideration shall not be given to claims that the substituted item meets the performance requirements with lesser construction. Performance indicated in schedules, drawings and specifications shall be interpreted as minimum performance.
- B. Note that where specific manufacturers' products are indicated in the Contract Documents, the associated systems have been designed on the basis of that product's physical characteristics. Where specific manufacturers' products are indicated in the Contract Documents and other manufacturers' names are listed, the associated systems have been designed on the basis of the first-named manufacturer's product. When products other than those used as the basis of design are provided, additional costs related installation, usage or modifications to the systems and/or structure required by the use of that product shall be paid by this contractor.
- C. This Contractor shall be responsible for all costs associated with changes to sizes such as conduit, fuse, starter, wire, supports etc. caused by change of equipment from the basis of design including usage of other named manufactures. Space allocation due to usage of other manufacture shall be the responsible of the Contractor ensuring adequate clearances for maintenance, operation, service, code requirements are met.
- D. Equipment of one type shall be the products of one manufacturer; similar items of the same classification shall be identical, including equipment, assemblies, parts and components.
- E. Materials furnished shall be new, defect free, used in accordance to its listing and determined safe by a nationally recognized testing organization, such as Underwriters' Laboratories, Inc., or Factory Mutual Engineering Corporation, and materials shall be labeled, certified or listed by such organizations.
- F. Where a specific manufacturer is specified and other manufacturers' names are listed as equivalent, the bid shall be based upon the specified or equivalent manufacturers only. Any substitutions shall be submitted to the associate no later than ten (10) days prior to the bid opening. Refer to Article I and the General Conditions of this specification for more information.
- G. Final acceptance of substitutions shall be at the discretion of the associate.

1.15 PERFORMANCE OF EQUIPMENT

- A. Materials, equipment and appurtenances of any kind, shown on the drawings, hereinafter specified or required for the completion of the work in accordance with the intent of these specifications, shall be completely satisfactory and acceptable in operation, performance and capacity. No approval either written or verbal of any drawings, descriptive data or samples or such material, equipment and/or appurtenance shall relieve the Contractor of his responsibility to turn over the same to OWNER in perfect working order at the completion of the work.
- B. Any material, equipment or appurtenances, the operation, capacity or performance of which does not comply with the drawings and/or specification requirements or which is damaged prior to acceptance by OWNER shall be held to be defective material and shall be removed and replaced with proper and acceptable materials, equipment and/or appurtenances or put in proper and acceptable working order, satisfactory to the Owner, without additional cost to the Owner.

1.16 WEATHERPROOFING LOCATIONS (WP)

- A. Electrical apparatus, such as outlet boxes, switches, thermal switches, manual starters, disconnect switches, combination switches and starters, motor control centers, and motor starters shall be weatherproof gasket type, NEMA Types 4 in the following instances:
 - 1. On surface of exterior face of building, including areas where not under canopies, cast boxes with threaded hubs must be used and under canopies steel boxes with gasket connections to devices.
 - 2. In any areas where specifically noted "WP" or required by the NEC or Electrical Regulations mentioned herein.
 - 3. Within air conditioning enclosures.
 - 4. In underground splice boxes.
 - 5. On building roof.

1.17 CLEANING, PROTECTING AND ADJUSTING

- A. Materials shall be stored in a manner that shall maintain an orderly, clean appearance. If stored on-site in open or unprotected areas, equipment and material shall be kept off the ground by means of pallets or racks, and covered with tarpaulins.
- B. Equipment and material, if left unprotected and damaged, shall be repainted or otherwise refurbished at the discretion of the Owner. Equipment and material is subject to rejection and replacement if, in the opinion of the Associate or the manufacturer's engineering department, the equipment has deteriorated or been damaged to the extent that its immediate use or performance is questionable, or that its normal life expectancy has been curtailed.
- C. During the construction period, protect ductwork, raceways, conduit and equipment from damage and dirt. Properly cap ductwork and conduit.
- D. Vacuum cabinets, switch boards, distribution panels, lighting and power panels, etc., after completion of work.
- E. Remove recorded construction measurements from equipment, panels, walls or other defaced surfaces.

1.18 ACCESSIBILITY

- A. Coordinate to ensure the adequacy of the size of shafts and chases, and the adequacy of clearances in hung ceilings and other areas required for the proper installation of this work.

- B. Locate equipment which must be serviced, operated or maintained in fully accessible positions. Equipment requiring access shall include, but is not necessarily limited to, motors, junction boxes, fire alarm devices, controllers and switchgear.
- C. Provide, as required, the exact locations of access doors. Provide access doors in finished construction for installation by others. Locations of access doors in finished construction shall be submitted in sufficient time to be installed in the normal course of the work. Keep conduit and other electrical devices clear of access door openings to allow adequate space to work in or enter the concealed space.
- D. Access panels shall not be smaller than 12 inches by 16 inches or as required by authority of jurisdiction and shall be all-steel construction with a No. 16 gauge wall or ceiling frame and a No. 14 gauge panel door with not less than 1/8 inch fireproofing secured to the inside of the door. Doors shall be provided with concealed hinges and be secured with suitable clips and countersunk screws. Outside of access panels shall finish flush with finished wall or ceiling surfaces. Covers shall be factory primed with two (2) coats of primer.
- E. Working clearances: Provide at least 3'-0" of clear space in front of all electrical panels and as wide as the equipment with a minimum of 2'-6" wide. Height and width of working spaces shall be in accordance to Article 110.26 of National Electric Code.

1.19 GUARANTEE

- A. Guarantee material, equipment and workmanship for a period of one (1) year from date of final acceptance by Associate and Owner's Representative. Replace defective material and workmanship furnished and installed and other work and equipment damaged thereby.
- B. In addition to the one (1) year guarantee, furnish any warranties or guarantees that normally come with specific pieces of equipment that exceed the one (1) year guarantee. These additional warranties shall be given to OWNER for the time period specified.

1.20 COORDINATION

- A. The General Contractor shall be in charge of the coordination drawing process and shall be responsible to resolve all conflicts and settle any disputes resulting from the coordination drawing process. Coordinate and furnish in writing to other Primes, including the Associate, any information necessary to permit the work of all contractors to satisfactorily complete installation of their work with the least possible interference or delay.
- B. Each Prime Contractor shall participate in the preparation of coordination drawings. No installation of permanent systems shall proceed until the coordination drawings are approved by the General Contractor. No extra charges shall be allowed for changes required to accommodate installation of system by other contractors.
- C. Coordination drawings shall be prepared in Revit 2014 format for each floor level and shall be of a scale not less than 1/4 inch - 1 foot. Coordination drawings shall include equipment, lighting, telecommunication, fire alarm, cable tray and raceway plans, with elevations with dimensions. Coordination drawings shall also include required access points through ceiling panels, access doors, cover plates, etc.
- D. Field discrepancies shall be resolved by the field foreman. When discrepancies cannot be resolved, the signed-off coordination drawings shall be re-examined for rights. Any and all discrepancies in construction, phasing, etc., due to the lack of coordination shall be at the sole expense of the associated contractors and in no way will be passed on to OWNER.
- E. Devices and appurtenances which are to be installed in finished areas shall be coordinated with the General Contractor and OWNER for final approval as it relates to location, finish, materials, color, and texture.

- F. When work is installed without proper coordination, changes to this work deemed necessary by the Associate shall be made to correct conditions without any extra cost to OWNER.
- G. Disciplines shall include in coordination: Electric, Telecommunications, HVAC, Mechanical, Plumbing, Fire Protection and Fire Alarm System.
- H. Related coordination specification in Division 01.

1.21 PRE-BID SITE VISIT

- A. Before submitting a bid, the Bidder is required to visit the site and fully inform themselves concerning all conditions affecting the scope of the work. Any discrepancies between the contract documents and the job site shall be brought to the Contract Officer's attention before bids are due. Failure to visit the site shall not relieve the Contractor from any responsibility in the performance of this Contract. No extra charges shall be allowed as a result of existing conditions.

1.22 DRAWINGS

- A. The Electrical drawings are diagrammatic and indicate the general arrangement of fixtures, equipment, furniture and work included in this contract. Consult the project documents and details for locations and dimensions of such equipment. All dimensions shall be field verified prior to material ordering. Where such items are not dimensioned or properly detailed, contact the Architect for required information.
- B. The Electrical Contractor shall follow the drawings in laying out work while checking drawings of other trades prior to installation. Maintain NEC required work clearances including overhead electric space requirements. Contact the Architect where clearances are inadequate prior to equipment installation.
- C. Where directed by the Architect, the Electrical Contractor shall modify layouts as needed to prevent conflict of work with other trades. No additional charges shall be made for coordination. Failure to coordinate with other trades or within project documents shall not relieve the Electrical Contractor from his responsibility or necessity of furnishing material or performing his work as required by the contract documents.

PART 2 - PRODUCTS

2.1 MATERIALS AND WORKMANSHIP

- A. Equipment shall be so built and installed as to deliver its full rated capacity at the efficiency for which it was designed. Equipment shall meet the detailed requirements indicated, and shall be suitable for the installation shown.
- B. Surface mounted electrical equipment shall be installed on 3/4" thick, fire retardant mounting board. Mounting board shall bear UL classified mark indicating ASTM E 84 test compliancy. Backboard material shall have a final applied finish according to manufacturer specifications prior to mounting of electrical equipment. Finishing material may include but not limited to fire retardant coatings. Backboard material shall minimally extend 6" in all directions beyond grouping of electrical equipment. The Electrical Contractor may use discretionary expertise to provide fire retardant backboard for individual equipment such as standalone disconnect switches, starters and the like. Where said devices are grouped (starters, disconnects, contactors etc.) installation shall include fire retardant backboard. Fire retardant mounting board installed on perimeter outside walls to be shimmed 1/2" from wall with washers to permit back ventilation.
 - 1. Approved manufacturer: Hoover Treated Wood Products Inc. - Pyro-Guard
 - 2. Approved equal.

- C. Where two or more units of the same class of equipment are furnished in same Section of Specifications, provide each from the same manufacturer. Furnish equipment and materials new and free from defects of size, make, type and quality herein specified, or as reviewed.
- D. Work shall be installed in a neat and workmanlike manner. Raceway installations shall parallel exterior and interior walls and be level. Vertical runs shall be plumb.
- E. Capacities, dimensions, or sizes specified or indicated are minimums, unless otherwise stated. Tolerances used in rating or testing standards specified shall not be allowed in determining capacities of equipment.
- F. Materials shall be listed by the Underwriters' Laboratories, Inc. where applicable and shall be manufactured in accordance with applicable standards established by ANSI, NEMA, ASTM, and IEEE.
- G. Any products judged not in accordance with the Specifications either before or after installation will be rejected. Costs associated with rejection shall be paid by this contractor.
- H. Where products are specified with no reference to a particular manufacturer's product, the product used shall meet or exceed industry construction and testing procedure standards applicable to the product, for life expectancy, performance and safety.
- I. Where electrical products are a fabricated assembly, the fabricator shall assume responsibility for correct operation of the entire assembly and of its individual components.
- J. Tools: Provide special tools for proper operation and maintenance of the equipment.
- K. It's the responsibility of the Electrical Contractor to provide clean electrical equipment which is free from dirt, paint, blemishes or markings. Scratches to equipment or enclosures shall be touched up with factory-color paint matching field color. Acceptance to restoration shall be to the satisfaction of the Architect.
- L. Required device or equipment adjustments shall be made by EC before and after equipment is in operation throughout the warranty period.
- M. Job site cleanliness and site safety of the removal of electrical generated trash or debris is the responsibility of this contractor. All job site safety rules, regulations and requirements shall be followed and maintained.

2.2 IDENTIFICATION

- A. Switchgear, panels, relays, terminal control cabinets, junction boxes, contactors, circuit breakers, safety switches, motor starters, and similar items shall be identified with a single nameplate. Nameplates shall be laminated phenolic with white surface and black core (red surface for emergency and white core). Use 1/16" thick material for plates up to 2" x 4" and 1/8" thick for larger sizes. The lettering shall be condensed gothic with space between the lines equal to the width of the letters.
- B. Nameplate shall read as follows:
 - 1. First line shall be 1/2 inch letters stating panel/equipment name.
 - 2. Second line (if applicable) shall be 1/4 inch letters stating the existing panel name in parentheses ().
 - 3. Third line shall be 1/4 inch letters stating voltage/phase.
 - 4. Fourth line shall be 1/4 inch letters stating breaker number, panel number, and final room name/room number from which it is fed.
 - 5. Fifth line shall be 1/4 inch letters stating function and/or equipment which it controls.
- C. Names and numbers shall coincide with those listed within Contract documents unless altered by Owner descriptors.
- D. Nameplates shall be secured with screws, a minimum of one on each end.

- E. Label receptacle plates with identification showing panel and breaker number from which it is fed. Labels shall be made using the Dymo RinoPro or an equivalent system.
- F. Label junction boxes and pull boxes, showing circuit numbers contained in the enclosure. Use an approved marking device as noted.
- G. Label wire with an identification tag showing panel and breaker number from which it is fed at splices, junctions, and terminations as explained in this specification.
- H. Label fire alarm device bases with identification showing device address number assigned by fire alarm system manufacturer. Labels shall be made using the Dymo RinoPro or equivalent system.
- I. Branch breakers shall be labeled by Owner provided room numbers and descriptors.

2.3 ANCHOR BOLTS

- A. Provide and set in place, at the time of pouring of concrete foundations, necessary anchor bolts as required for the equipment called for under these specifications. Anchor bolts shall be of the hook type, of proper size and length to suit the equipment. Anchor bolts shall be set in pipe sleeves of approximately twice the bolt diameter and one half the embedded length of the bolt. Assume full responsibility for proper emplacement of the bolts.

2.4 INSERTS

- A. Provide inserts of an approved metallic type for hangers. Where two or more parallel conduits are installed, continuous inserts may be used. Where required to distribute the load on the inserts, a piece of reinforcing steel of sufficient length shall be passed through the insert.

2.5 SLEEVES

- A. Provide sleeves in all roofs, floors, and any fire-rated walls. Each sleeve shall extend through its respective floor, wall or partition and shall be cut flush with each surface unless otherwise required.
- B. Sleeves in bearing and masonry walls, floors and partitions shall be standard weight steel pipe finished with smooth edges. For other than masonry partitions, through suspended ceilings, and for concealed vertical piping, sleeves shall be No. 22 USG galvanized iron.
- C. Sleeves shall be properly installed and securely cemented in place.
- D. Floor sleeves shall extend 1 inch above the finished floor, unless otherwise noted. Space between floor sleeves and passing conduit shall be caulked with graphite packing and waterproof caulking compound.
- E. Where conduits pass through waterproofed floor or walls, design of sleeves shall be such that waterproofing can be flashed into and around the sleeves.
- F. Where conduits pass through roofs, sleeves shall be installed and flashed and made watertight by the General Contractor unless otherwise specified or shown within Contract documents.
- G. Sleeves through exterior walls below grade shall have the space between conduit and sleeve caulked watertight using an approved method.

2.6 FIREPROOFING

- A. Where sleeves, ducts, cable trays, or other penetrations pierce floors or walls having specific fire ratings, the space between the sleeves and passing conduit shall be fireproofed with an approved UL listed fire proofing assembly. Installation method shall be per manufacturer's recommendations and approved by the Associate.

- B. Reference Division 7, section “Through-Penetration Firestop System”.

2.7 WIRE GAUGE

- A. The sizes of conductors and thickness of metals called for herein or within other Contract documents shall be understood to be American Wire Gauge.

2.8 MISCELLANEOUS METAL AND STRUCTURAL STEEL

- A. Scope of Work: Furnish labor, materials, equipment and services necessary for the installation of miscellaneous metal and structural steel work required to complete this contract. Erect structural steel required for the proper support of equipment required under this contract.
- B. Supports, brackets, and clamps and other items specified herein shall be installed in strict accordance with the best practices and recognized code.
- C. Materials: Structural steel members required under this part shall conform to ASTM Standard Specification A-7. Other materials shall be as specified hereinafter.
- D. Priming: steel and iron work shall be primed with Rust-Oleum 769 or approved equivalent. Before priming, metal shall be thoroughly cleaned free from scale, rust and dirt.
- E. Anchors: Provide anchors, bolts, screws, dowels and connecting members, and do cutting and fitting necessary to secure the work to adjoining construction. Build in connecting members to masonry, concrete and structural steel as the work progresses.
- F. Supports and Brackets: shall be neatly constructed to structural shapes to adequately support the equipment intended. Supports must be approved prior to installation. Attention is directed to the proper rigid support required for conduit. Field conditions shall regulate the type of support required.
- G. Reference Division 7, Section “Spray fire-resistive Material” for coordination of hangers and applicable supports.

2.9 VIBRATION ISOLATION MOUNTS

- A. Provide vibration isolation mounts for all substations, power centers, transformers or equipment subject vibrations in accordance with this or other applicable sections.

2.10 GRADING, FERTILIZING, AND SEEDING

- A. Provide labor, materials, equipment, and services required to strip and store topsoil, replace topsoil, and rough and finish grade and fertilize and seed areas disturbed beyond the work area of the General Contract. Topsoil must be stored where directed on the site.
- B. Reference Division 31, “Earthwork” for backfill and compaction requirements.

2.11 MOTORS

- A. Motors shall be built in accordance with the latest standards of NEMA and as specified. Motors shall be tested in accordance with ASA C50 and conform thereto with respect to insulation resistance and dielectric strength.
- B. Each motor shall be provided with conduit terminal box and adequate starting and protective equipment as specified or required. The capacity shall be sufficient to operate associated driven devices under conditions of operation and load and without overload, and shall be at least the horsepower indicated or specified. Each motor type shall be premium energy efficient and of quiet operation.

- C. Motor starting equipment must be selected so that starting currents or transients do not have an adverse effect on lighting or other electrical equipment. This contractor shall provide devices or equipment required to snub or eliminate such electrical disturbances.
- D. Motors shall be verified for proper rotation prior to service of equipment.
- E. Motors connected to inverter controllers shall comply with the requirements of Division 23 Specification 230513 "Common Motor Requirements For HVAC Equipment" when included in Contract Documents.
- F. Motors shall comply with Energy Independence and Security Act of 2007.
 - 1. Motors shall comply with NEMA MG 1 table 12-11 and 12-12 unless noted otherwise.
- G. Motors connected to inverter controllers shall be inverter rated containing shaft mounted grounding protection ring such as AEGIS bearing protection ring.

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide information to the General Contractor for any chases or openings required under this Contract. No cutting shall be done which may affect the building structurally or architecturally without the prior approval of the Associate. Damaged construction shall be restored to its original conditions and finished to match the surrounding work. Refer to "Supplementary General Conditions" for the disposition of Cutting and Patching.
- B. Grades, elevations, and dimensions shown on the drawings are approximately correct; however, field check and otherwise verify such data at the site before proceeding with work.
- C. The Contractor shall be entirely responsible for apparatus, equipment, and appurtenances furnished by him or his subcontractors in connection with the work and special care shall be taken to protect parts thereof in such manner as may be necessary or as may be directed. Protection shall include covers, crating, sheds or other means to prevent dirt, grit, plaster or other foreign substances from entering the working parts of machinery or equipment. Special care shall be taken to keep open ends of pipes closed while in storage and during installation. Where equipment must be stored outside the building, it shall be totally covered and secured with heavy weatherproofing tarps and kept dry at all times. Where equipment has been subjected to moisture, it shall be removed from the site and replaced with new equipment. Protect open excavating until covered over.
- D. Due to the schematic nature and small scale of the electrical drawings, it is not possible to indicate exact locations, offsets, fittings, access panels, pull boxes, and miscellaneous parts which may be required to form a complete system. The drawings are generally indicative of the work to be installed. Arrange work accordingly furnishing necessary parts and equipment as may be required to meet the various conditions and to provide a complete circuit from end use device to circuit protective device in panel.
- E. Within thirty (30) days after acceptance of bids, submit to the Associate for approval, a complete list of equipment and materials to be furnished under this contract, giving names and addresses of manufacturers and material cut sheets they intend to furnish.

3.2 CLEARANCES

- A. Take caution when routing conduit and location of equipment. In many cases, ceiling (plenums) clearance is limited due to ductwork and other mechanical lines, systems and structural steel. The Contractor shall be responsible for routing around mechanical equipment and ducts in order that everything can remain concealed in finished areas.

3.3 CUTTING AND PATCHING

- A. Provide cutting and patching necessary to install the work specified herein. Patching shall match adjacent surfaces. Refer to Section 01731, Cutting and Patching, for specific direction.
- B. No structural members shall be cut without prior approval of the Associate, and such cutting shall be done in a manner directed by the Associate.
- C. Provide ceiling removal and replacement where work above finished ceilings is required. Replace ceiling components damaged in the process.
- D. Provide patching where electrical devices are removed from or through walls, ceilings or floors.

3.4 PAINTING

- A. Finished painting shall be performed by this Contractor except for standard factory finishes.
- B. Electrical motor's, pump casings, and other similar items shall be provided with three coats of machinery enamel at the factory, and shall be carefully cleaned, rubbed down, and oiled after installation.

3.5 LOCATIONS

- A. Apply for detailed and specific information regarding the location of equipment as the final location may differ from that indicated on the drawings. Outlets, equipment or wiring improperly placed because of failure to obtain this information shall be relocated and re-installed without additional cost to the Owner. Determine the actual direction of door swings, so that local switches and other controls shall be installed at the lockside of doors, unless otherwise noted. Improperly located switches shall be relocated without additional cost to the Owner.
- B. The design shall be subject to such revisions as may be necessary to overcome building obstructions. No changes shall be made in location of outlets or equipment without written consent of the associate.
- C. Unless otherwise mentioned or indicated, mounting heights of outlets are shown on the drawings or in the specification. Dimensions given shall be considered to be from center of outlet to finished floor.
- D. Coordinate the exact location and elevation of all electrical devices and fixtures with the architectural interior elevation plan and reflective ceiling plan prior to installation.
- E. Properly rough in for the electrical conduit and equipment under this contract and modify as required for coordination during the construction period.

3.6 RECORD DRAWINGS

- A. During the construction period, maintain in good order a complete set of as-built electrical contract drawings. Record the actual electrical installation as the work progresses. Include changes to the contract and to equipment sizes and types. Keep these drawings available at the site at all times for inspection.
- B. Take proper caution against the use of superseded drawings. Check such copies and mark "void." Where drawings have been corrected by memorandum, assume the responsibility for marking all drawings so affected with the changes; such marked drawings shall remain in use until revised drawings are issued.
- C. At the conclusion of the work, provide to the Associate a complete set of drawings which indicate precisely how the electrical system, single line, and riser diagram equipment has been installed. Return such reproducible drawings within 30 days to the Associate.

3.7 EQUIPMENT, FOUNDATIONS, SUPPORTS, PIERS AND ATTACHMENTS

- A. Provide necessary foundations, supports, pads, bases and piers required for equipment specified in this division; submit drawings in accordance with Shop Drawing Submittal requirements prior to the purchase, fabrication or construction of same.
- B. Provide concrete pads for base-mounted transformers and Electric Contractor provided rotating equipment and for other floor mounted electrical equipment. Pads shall be extended 6 inches beyond matching base in all directions with top edge chamfered. Inset 6 inch steel dowel rods into floors to anchor pads.
- C. Construction of foundations, supports, pads, bases and piers, where mounted on the floor, shall be of the same materials and same quality of finish as the adjacent and surrounding floor material.
- D. Equipment shall be securely attached to the building structure in an approved manner. Attachments shall be of a strong and durable nature and any attachments that are, in the opinion of the Associate, not strong and durable shall be replaced as directed. Reference Division 3 "Concrete".

3.8 SCAFFOLDING

- A. Furnish and erect scaffolding and ladders required in the installation of wiring, raceways, cable tray, equipment and lighting fixtures.

3.9 ENVIRONMENTAL AIR PLENUMS

- A. In spaces over suspended ceilings which are used for environmental air handling purposes as defined by Article 300.22C of the National Electric Code, power, data and communications cables must be in conduit or of the type cable rated for air plenum use. This Contractor shall be responsible to clearly define ceiling space used for environmental air purposes, provide material and installations meeting installation environment.

3.10 HAZARDOUS LOCATIONS

- A. In hazardous locations as defined by Article 500 of the National Electrical Code, electrical work installed in these areas shall be installed in accordance with the requirements of Article 500 whether specifically called for or not. Fixtures, fittings, and devices shall be installed according to, be rated for area of installation and meet requirements of binding code, including devices, seal offs, etc. Determine such areas as defined by the NEC and NFPA and conform to requirements of the enforcing agencies.

END OF SECTION 260500

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SECTION 260512 - ELECTRICAL POWERED EQUIPMENT

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions, General Requirements and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION

- A. This section of the specifications describes the principal electrical work related to the installation, connection, and control of electrical powered equipment furnished under other divisions. Should examination of related effort indicate discrepancies or omissions, request clarification prior to bidding, performing or omitting any required work.
- B. Examine Contract documents and other divisions of these specifications to ascertain the extent of powered equipment covered by the drawings and specifications and the method by which each item of equipment shall be furnished, delivered to the site, installed, and the amount of electrical work which shall be included with the powered equipment. Verify the voltage and frequency requirements of electrical equipment as it is delivered to the site. If voltage and frequency are not compatible with the building electrical system, immediately inform the Associate in writing. Particular attention is called to the following items:
 - 1. Mechanical equipment
 - 2. Specialized equipment
 - 3. Owner furnished equipment
- C. Definition:
 - 1. Wiring: Contactors, conduit, enclosures, connections, labor and miscellaneous material required to supply power to powered equipment and associated controls for proper operation.
- D. Motor Installation and Connections: utility motors such as fans, pumps, etc., are furnished under applicable sections of specifications. Those not provided as an integral part of the mechanical equipment, shall be delivered to this contractor at the point of installation. Receive these motors, handle, store (if required), and provide power wiring, including a phasing rotation check for applicable motors. Connect each motor to a separate branch circuit, feeder and include disconnecting means except where noted. Terminate conduit to motors in final connection with liquid tight flexible conduit. Equipment frames shall be bonded per National Electrical Code.
- E. Control Devices and Wiring: Control devices (such as pressure switches, floats, electrodes, P.E. switches, E.P. switches, relays, thermostats, etc.), prewired in packaged type equipment and/or control panels shall be provided by the appropriate contractor. Provide required interlocking control, time delay relays, control transformers, break-glass stations, remote pushbuttons required to perform functions indicated within Contract documents including requirements of local authorities.
- F. Verify motor rotation for equipment before it is turned over to other Contractors or Owner.
- G. Furnishing and installation of control devices, control panels, and control wiring for HVAC equipment shall be provided under Division 23.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Refer to other related sections of Division 23 for applicable materials. Particular attention is called to the following sections:
 - 1. Section 262813, Fuses
 - 2. Section 262913, Motor Starters

PART 3 - EXECUTION

3.1 ELECTRICAL WORK FOR MECHANICAL EQUIPMENT

- A. Motors and Motor Controls: Pre-wired packaged type equipment, control devices, control panels and alarm panels for Mechanical Work, shall be furnished and installed under other sections of the specifications and wired under this section of the specifications, except as otherwise noted. Control devices which have piping connections shall be installed under other sections of the specifications. Where wall space is not available, provide suitable primed and painted angle iron framework supports for mounting of starters and controls. Power wiring shall be provided to motors, starters, variable frequency drives, consoles, and each refrigeration machine, electric boilers, and auxiliaries. Perform required adjustments, wiring modifications, in conjunction with any testing and operational system start-up procedures. In general, starters, disconnects, switches and fuses shall be furnished under Division 23 and wired under this division.
- B. Responsibility: Electrical work specified in Division 23 as "by the Electrical Contractor" is an obligation of this contractor, the same as if specified herein.
 - 1. Electric Heaters (Plumbing or HVAC): electric heaters are furnished under other Sections. Provide power wiring at heaters. Thermostats for heaters furnished under other sections.
 - 2. Control Wiring for HVAC Systems: control wiring of HVAC equipment shall be under Division 23 unless noted otherwise.

END OF SECTION 260512

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SECTION 260519 WIRES & CABLE

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions, General Requirements, Division 1 Specifications, apply to this Section.

1.2 DESCRIPTION

- A. Provide all wires and cables in accordance with the Contract Documents for service, feeders, branch circuits, lighting, systems, egress, control wiring and telecommunications.
- B. This section includes cable requirements for systems below 600 volt insulation.
- C. Conductors shall be soft drawn stranded copper having conductivity not less than 98 percent.
- D. Aluminum conductors are not allowed.
- E. All wiring and cables shall be installed in raceway unless otherwise noted.
- F. Conductors shall be insulated for minimum of 600 volts. Motor conductors (T-leads) controlled by variable frequency drives shall have a minimum rating of 1000 volts for voltages over 240v.
- G. All conductors shall be U.L. labeled and installed in accordance to the NEC.
- H. Insulation types are the type referenced in NEC.

PART 2 - PRODUCTS

2.1 600 VOLT WIRE OR LESS

- A. Conductors shall be “UL” approved stranded copper with a minimum insulating rating of 600v.
- B. Manufacturers:
 - 1. Southwire Company
 - 2. General Cable Corporation
 - 3. American Insulated Wire Corporation
 - 4. Approved Equal.
- C. Type of conductor insulation for general use shall be as follows, subject to limitation listed:
 - 1. Type THW – no restrictions
 - 2. Type THHN/THWN – restrictions as follows:
 - a. Do not use for conductors in/under slab.
 - b. Do not use in wet locations.
 - 3. Type XHHW – no restrictions.
 - 4. Fixture wiring shall be single conductor, 600 volt, 200°C, Type SF-2, stranded silicone rubber insulation with overall glass braid.

- a. Wiring routed within ballast trough shall be high ambient wire: single conductor, 600 volt, 125°C minimum, Type SA stranded silicone rubber insulation with overall glass braid.
5. Fire alarm cable: EC to provide all power and signal circuits for the fire alarm system. Wire and cable requirements must meet NEC and that of fire alarm system Manufacturer. Refer to Specification 28 31 00 for cable types and usage.

2.2 TYPE MC CONDUCTOR CABLE

- A. MC conductor cable usage is only approved for connections to ceiling grid mounted light fixtures (from overhead powered junction boxes). MC cable shall be constructed with insulated phase(s), neutral and one full size green conductors. Branch circuit type MC cable (14-6 AWG) shall use copper conductors. All MC conductors shall be type THHN/THWN-2 600v stranded.
- B. Manufacturers:
 1. AFC Cable System
 2. General Cable
 3. Alcan Cable
 4. Southwire
 5. Approved equal

2.3 PLENUM CONDUCTOR CABLE

- A. Plenum conductor cable may be used for NEC Class 2 or 3 wiring if conductor cable is UL listed in accordance with UL 910 and UL 1820 and is installed in accordance with the NEC and is acceptable to the Authority having jurisdiction. Insulation types, UL listing, and written acceptance by the local authority shall be submitted for review.
- B. Installation of cables shall be installed in a neat and workmanship like manner. Cables shall be supported conforming to the requirements of the latest edition of National Electrical Code and Electronics Industries Association and Telecommunications Industries Association.

2.4 CONNECTORS & LUGS

- A. See Specification 262730 "Taps, Splices & Terminations"

2.5 ADJUSTABLE FREQUENCY DRIVES (AFD/VFD)

- A. Motor Conductors for voltages greater than 240v and length exceeding 45ft from AFD/VFD:
 1. Cable characteristics:
 - a. As recommended by AFD manufacturer and meet minimum requirements: UL standard 44, 1277, MSHA & TC-ER approved, 600-1000 volt rated, 90°C, XLPE insulation with copper tape shield with symmetrical grounds. Wire gage sized per NFPA 70-460.6(A).
 - b. Manufacturer:
 - 1) LAPPUSA Olflex VFD Symmetrical
 - 2) SAB Associated Wire Products (SAB North America)
 - 3) Belden - Large VFD Symmetrical Design

- 4) Approved equal
- 2. Bending radius: Electrical Contractor shall provide means of maintaining motor conductor minimum bending radius throughout protective raceway, pull boxes and terminations.

2.6 MOTOR TERMINATIONS

- A. Motor branch conductors larger than #10 AWG shall be connected to the factory motor leads with compression type connector. Field wiring and factory wiring shall be terminated with individuals crimp type, single indent terminal lugs. Crimp connections shall be sized fro the connecting wires, type and construction. Individual connections shall be joined through bolting with a combination of bolt, nut, flat and locking washer.
- B. Conductive motor terminals shall be insulated and sealed with factory engineered motor connection kits. Connection kits shall be rated for voltage, insulation class and dielectric strength. Connection kits shall be rated for 90°C continuous conductor operation. Motor connection kits shall be equal to type RVC or MCK as manufactured by Raychem Corporation or equal by 3M or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide circuit wiring complete as shown as called for within Contract documents, and as hereinafter specified or required. The minimum size of wire for branch circuits shall be No. 12, except 120 volt circuits over 100 feet in length shall be No. 10; 120 volt circuits over 150 feet in length shall be No. 8. Wiring shall be increased in size if so demanded by wattage of load.
- B. Voltage drop calculations shall be performed by the electrical contractor. Conductors sized shall be increased where branch circuit calculations result in a voltage drop greater than 3%.
- C. 600 volt wiring shall be color coded. Consistent phase identification of wires from service feeders to branch circuit wires shall be maintained as follows:
 - 1. 120/208 volts - Normal - Phase A Black
 - 2. 120/208 volts - Normal - Phase B Red
 - 3. 120/208 volts - Normal - Phase C Blue
 - 4. 120/208 volts - Neutral..... White
 - 5. 120/208 volt - Ground Wire Green
 - 6. 277/480 volt - Phase A Brown
 - 7. 277/480 volt - Phase B Orange
 - 8. 277/480 volt - Phase C Yellow
 - 9. 277/480 volt - Neutral Grey
- D. Fire alarm wiring or cable color coding shall be RED or per manufacturer’s recommendation.
- E. Labeling: Electrical contractor shall identify each termination via a permanent printed type “Brady” wire marker as noted.
- F. Do not pull wires into raceways until raceways are permanently in place, thoroughly clean, and termination points are not subject to damage. Usage of pulling lubricants shall be applied sparingly.

- G. Do not use uninsulated wire conductors.
- H. Provide excess free conductor end length at termination points, adequate to make up splices and terminations, permitting neatly training conductors, and in any case not less than:
 - 1. No. 14 through 10 AWG - 8 inches
 - 2. No. 8 or 6 AWG - 12 inches
 - 3. Larger than No. 6 AWG - 18 inches
- I. Support vertical cables as required by Code. Use lock type cable support bushings having internal wedges and retaining collars. Locate support points in readily accessible pull boxes sized to code requirements.
- J. Control circuit wiring in cabinets, panels, pull boxes, etc., shall be tied, bundled and held with Thomas & Betts Nylon Self-Locking Ty-Raps, or approved equal.
- K. Large equipment pull, junction or terminal boxes shall contain suitable racks to support, arrange, and retain wire and cable in an orderly manner.
- L. Equipment conductors smaller than No. 4 AWG, in wireways, gutters, pull boxes, terminations, etc., shall be identified with wire markers. Designate panel and circuit number on each individual marker.
- M. Feeder or equipment conductors No. 4 AWG or larger, shall be individually identified with metal, fiber or fireproof linen tags or with wrap around markers. Designate panel circuit number on each individual marker. In addition, designate use of each set of conductors on a common tag or on each individual conductor marker. Tagging shall include panel source and feeder size of equipment supply.
- N. Switchboard and distribution panelboards with ratings greater than 10,000 RMS symmetrical amperes shall have supply cables braced in accordance with board manufacturer bracing requirements where such panels are approved for bracing.
 - 1. Wrapping of cables: Wrap line cables together with nominal 3/8-inch nylon rope or rope having a minimum tensile strength of 2000 pounds at 6 inches and 12 inches from the line terminals with minimum of five non-spaced wraps.
 - 2. For electrical equipment that is not clearly marked as to whether or not cable bracing is required, contact the Manufacturer's representative.
- O. Where the single pole work is used on branch circuits, circuit wiring shall have a dedicated neutral conductor. Do not gang or share neutrals. The Contract documents are schematic and diagrammatic and indicate the general method of installing circuit wiring and the outlets which are to be supplied.
- P. Lighting and convenience outlet circuiting are indicated on the Contract documents separately as single pole work for clarity; however, the Electrical Contractor shall provide a minimum of 20 percent spare future capacity in each raceway.
- Q. All branch circuits shall have a dedicated neutral conductor. Sharing neutrals is not permitted.
- R. The minimum sizes of wire on an installation shall be as follows:
 - Emergency and Exit Circuits10 AWG
 - Lighting and Power Circuits12 AWG
 - Signal Circuits - with common or individual leads14 AWG
 - Remote Control LeadsAs recommended by manufacturer

Low Voltage Light Control, Communication,	Twisted Pair, Shielded or as recommended by manufacturer
Data, and Fire Alarm Systems	Shielded or recommended by manufacturer
Fixtures	14 AWG Min. SF-2 and as required by Underwriters Laboratories and National Electrical Code

- S. Install in each empty interior conduit, one nylon measuring fish line for the future installation of wire or cables.
- T. Great care shall be exercised in pulling wires into the conduits so as not to injure the insulation. Only UL approved lubricants shall be used to assist in the pulling in of wires with an outer covering or braid.
- U. Where switch boxes are used as the termination of the "home runs" in addition to the switch legs, not less than a two-gang box shall be used.
- V. The size and general location of the various feeders or branch circuits are approximately shown. However, the electrical contractor shall determine and coordinate the exact location and routing at the site.
- W. Seal around conduits penetrating fire-rated elements according to Division 7, Section "Through-Penetration Firestop Systems".
- X. Communications, sound, dimming, fire alarm, data and other low voltage wiring shall be of size by the manufacturer of the equipment being served and cable type as required by the National Electrical Code.
- Y. Branch circuits to be connected as numbered within Contract documents. Prior to energizing, test cable and wire for continuity of circuitry, and also for short circuits. Correct malfunctions when detected.
- Z. In every pull or splice box and all other places where wires and cables may not be readily identified by nameplate on the equipment to which they connect, each circuit shall be identified with a permanent identification tag securely fastened to the conductors.

END OF SECTION 260519

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SECTION 260526 GROUNDING & BONDING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions, General Requirements and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION

- A. Provide all system equipment and static grounding in accordance with the Contract Documents and in full compliance with the latest edition of National Electrical Code, and the Authority having jurisdiction. Grounding requirements specified in this section may be supplemented by special requirements of systems described in other sections such as Section 27 10 00 "CABLE".
- B. Ground every device and metal part of the electrical system including all enclosures, fixtures, boxes, feeders and branch circuits over 40 volts shall include a copper grounding conductor sized in accordance with NEC Table 250.122 except not smaller than #12 for power and lighting circuits and #14 for control circuits.
 - 1. All equipment ground conductors shall have green colored insulation.
 - 2. Isolated ground conductors shall have green colored insulation with yellow stripe.
 - 3. Feeders to have alternating, three (3) green and two (2) yellow bands of tape.
- C. Maintain continuity of system and equipment grounds throughout the electrical installation unless specifically shown otherwise. Provide ground bushings and jumpers where normal metallic ground paths are interrupted or unreliable.
- D. Grounding shall be accomplished by means required by NEC and generally outlined in the subsequent paragraphs.
- E. Grounding shall be connected to the water feed service pipe such as water heater and piping systems likely to become energized. Install a separate equipment grounding conductor to each electric water heater or heat-tracing system complying with manufacturer's installation specifications. Bond conductor to heater units, piping, connected equipment and relevant components.
- F. All electrical equipment, cabinets, boxes, conduit, metal fixture poles and metal raceways shall be grounded in accordance with the NEC and as specified herein.
- G. All connections to apparatus and conduits shall be made with an approved UL type of bolted or compression connector. Connectors shall be securely fastened to the equipment. All contact surfaces shall be thoroughly cleaned and bright before connections are made in order to insure a good metal-to-metal contact.
- H. All underground ground cable splicing or connections shall be exothermic welded.
- I. Tie all grounding systems together at their origins and as called for by the NEC or authority of jurisdiction.
- J. A solid ground shall be provided for the complete conduit system, feeder neutrals, motor frameworks, transformer cases, neutral of 480 volt and 208 volt building services, heating equipment enclosures, telecommunications and other items as required.

1.3 GROUNDING SYSTEM

- A. Grounding electrodes shall be installed and interconnected according to NEC Article 250.50.
 - 1. Bond water supply piping system in accordance with NEC Article 250.52

2. Per NEC Article 250.52(A)(3), provide a concrete-encased foundation electrode and bond to other electrodes per NEC.
3. Provide building ground ring with connections to structural steel columns in accordance to NEC Article 250.52(A)(4) at locations as shown within Contract documents. Steel columns shall be connected to the grounding electrode system with bare stranded copper where shown on contract documents or required by NEC or Authority having jurisdiction. Size bonding conductor in accordance to NEC Article 250. Connections to steel columns shall be made above grade using exothermic connection within web of column.
- B. Provide insulated copper grounding conductors in conduit for metal water service pipe from building's main service equipment, or grounding bus, to main metal water service entrance. Connect grounding conductors to main metal water service pipes by approved grounding 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.
- C. Where installed, vertical drops from the lightning protection loops shall be connected at points located on the lightning protection plan(s). Drops shall connect first to a driven ground rod outside building then to ground loop.
- D. Individual grounding risers for power, data/communications, security, and fire alarm closets shall be of wire type and sized as required by manufacturer or as specified elsewhere in specifications. Telecommunication bus bar shall be provided by this contractor and installed per BiCSi and EIA/TIA standards.
- E. Where any ground conductor required protection from physical damage, route conductor through a non-ferrous conduit or a steel conduit that's bonded at both ends.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Ground conductors shall be of size indicated or required by code.
- B. Ground rods shall be copper-clad steel, 3/4 inch diameter and 10 feet long.
- C. Connectors shall be as manufactured by Burndy, O.Z. Gedney, or Erico.
- D. Exothermic welding shall be Erico, Burndy, or O.Z. Gedney.
- E. Accessible connections shall be made with multiple bolt silicon bronze connectors specifically designed and approved for the connection to be made.
- F. Lighting fixtures shall be grounded by the use of a manufacture-supplied ground lug or pigtail or by the use of manufacture approved ground connection.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The neutral wire for the electrical system shall not be used to ground miscellaneous conduits.
- B. Ground wires required by the National Electrical Code shall be installed.
- C. The resistance between the grounding system and absolute earth shall not exceed values as specified and shall be measured in the presence of the Owner's representative.

- D. The equipment grounding terminal bars of the normal and emergency electrical system panel boards shall be bonded together with an insulated continuous copper bonding jumper not smaller than No. 6 copper or otherwise shown within Contract documents.
- E. Steel columns
- F. Electrically continuous metal raceway system shall not be used as the primary grounding or bonding conductor. A separate continuous grounding conductor shall be carried throughout the raceway system.

3.2 EQUIPMENT GROUNDING

- A. Conduit system shall be electrically continuous. All locknuts shall cut through enameled or painted surfaces on enclosures. Where enclosures and non-current carrying metals are isolated from the conduit system, use bonding jumpers with approved clamps. Where reducing washers are used and where concentric or eccentric knockouts are not completely removed, bonding bushings shall be required. Conduit crossing building expansion joints shall have provision for maintaining ground continuity.
- B. Cable shielding, metallic conduits, wireways, cable boxes, electrical equipment housings and all noncurrent carrying metallic parts shall be grounded. Run a separate ground wire to all equipment.
- C. All conduit stub-ups shall be grounded and where multiple stub-ups are made within an equipment enclosure, such as a switchboard, conduits shall be equipped with grounding bushings and bonded together and to the enclosure ground bus.
- D. Provide bonding devices, fittings or jumpers at expansion fitting, isolation sections or wherever continuity of ground is broken.
- E. Install all grounding conductors with sufficient slack, to avoid breaking due to settlement or movement of conductors or attached points. Installation of bonding straps or jumpers shall be provided for vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
- F. Motors shall be grounded by means of a grounding conductor located in the same raceway with the motor feeder connected to a grounding bushing at the motor terminal box and the ground bus from source of power or to the incoming conduit grounding bushing of an individually mounted motor starter.
- G. Where flexible metal conduit is used for all or part of a conduit run, except lighting branch circuits, a grounding conductor shall be provided in the conduit and connected to grounding bushings at each end of the run.
- H. Usage of steel core Liquid-Tight conduit shall have an exterior spiral wrapped green THHN bonding conductor terminating to external type grounding fittings using a minimum green #10 copper conductor.
- I. Under no circumstances shall a neutral conductor or neutral bar in an enclosure be used for grounding purposes.

3.3 FEEDER GROUNDING

- A. Run a separate insulated ground for feeders.
- B. Size grounds in accordance with the NEC or as noted within Contract documents whichever is more stringent.

3.4 FIELD QUALITY CONTROL

- A. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
- B. 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 (2)

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.

- C. Provide to Architect of record plan drawings locating each ground rod and 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.
 - 1. Equipment Rated 500 kVA and Less: 10 ohms.
 - 2. Equipment Rated 500 to 1000 kVA: 5 ohms.
 - 3. Equipment Rated More Than 1000 kVA: 3 ohms.
 - 4. Substations and Pad-Mounted Switching Equipment: 5 ohms
- D. Excessive Ground Resistance: If resistance to ground exceeds specified values, suitable and approved methods to reduce ground resistance shall be provided by this contractor.

END OF SECTION 260526

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SECTION 260529 - SUPPORTING DEVICES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions, General Requirements and Division 1 Specification Sections, apply to this Section.
- B. Reference Division 7, section “Spray Fire-resistive Material” for coordination of all hangers or applicable supports.

1.2 DESCRIPTION

- A. Provide products to suspend, attach, support and otherwise retain in location, electrical work.
 - 1. The specified requirements herein include support and hardware information of a general nature. Where additional requirements are stated elsewhere in the specification related to specific products and conditions, such additional requirements shall supersede these general specifications.
- B. Approvals: Obtain approval before cutting, drilling, or welding to, structural members. Where cutting, drilling, or welding is permitted, this work, as required for product support, is a part of product installation electrical work.
- C. Welding: Use certified welders for welded installation. Steel in weld area shall be cleaned before and after welding operations, and refinished after welding.
 - 1. Do not weld raceway pipe straps to structure.
 - 2. Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.3 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Use expansion shield anchors or toggle bolts of the following manufacturers:
 - 1. Phillips Drill Company, Inc. "Red Head Self Drilling"
 - 2. Rawl Products Company "Saber Tooth"
 - 3. McCulloch Industries "Kwik Bolt"
- B. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper B-Line, Inc.; a division of Cooper Industries.
 - b. Thomas & Betts Corporation.
 - c. Unistrut; Tyco International, Ltd.
 - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 5. Channel Dimensions: Selected for applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. 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.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. 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: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) MKT Fastening, LLC.
 - 3) 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: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head
 - 5) MKT Fastening, LLC.
 3. Mechanical Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 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, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

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 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 required by NFPA 70. Minimum rod size shall be 1/4 inch 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.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch 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.
- C. 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 thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches 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.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 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. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

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 minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Division 09 Section "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 INSTALLATION

- A. Provide common support trapezes for parallel raceways.
- B. Use manufactured preformed U-Channel system having accessory connecting and clamping devices available where parallel raceways are to be supported. Load channel system not to exceed manufacturer's recommendation.
- C. Fabricate supports for transformers, panel boards, cable tray, lighting fixtures, cabinets, pull and junction loads, and similar electrical products from preformed U-Channel systems. Load on channel system not to exceed manufacturer's recommendations.
- D. Support panelboards, disconnect switches, telecommunications, equipment, security, fire alarm panels, grounding bars and all other wall mount electrical equipment via $\frac{3}{4}$ " primed and fire treated plywood. Electrical equipment shall be mounted on said plywood in computer, telecommunication or electric rooms unless noted otherwise.
- E. Use preformed U-Channel concrete inserts preset into forms to secure hangers suspended from slabs.
- F. Use concrete expansion shield anchors or preformed U-Channel cast-in-place concrete inserts for attaching electrical products to concrete walls.
- G. Support loads from stud anchors or concrete inserts at not to exceed manufacturer's live loading recommendations.
- H. Do not drill holes or install driven fasteners in concrete at less than 12 inches from prestressed steel.
- I. Do not use nylon or similar concrete inserts without prior approval, except for supporting 1 inch or smaller individual runs of conduit or tubing.
- J. Use toggle bolts to attach supports for electrical products to hollow masonry walls. Do not attach products weighing more than 50 pounds to hollow masonry walls, without prior approval.

END OF SECTION 260529

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SECTION 260533 - RACEWAY & BOXES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions, General Requirements, Division 1 Specifications, apply to this Section.

1.2 DESCRIPTION

- A. Provide concealed or surface mount raceway as required to complete work indicated on the Contract Documents. Installed raceways shall be plumb and level. Raceways and backboxes shall be provided for Technology, Fire Alarm, Security and Other Trades in non-residential spaces.
 - 1. Raceways and backboxes shall be “RED” in color for all fire alarm related wiring.
 - 2. Raceways and backboxes shall be “YELLOW” in color for all emergency circuits derived from emergency panelboards as noted within Contract documents.
- B. All wiring shall be in conduit unless otherwise noted. Conduit shall be concealed in finished areas and may be exposed in unfinished areas such as mechanical and electrical areas. Conduit runs shall be continuous from outlet to outlet, fitting, pull or junction box, to cabinet or panel; and shall be mechanically secured electrically continuous.
- C. Minimum conduit size is 3/4". Where required, maximum lengths of 3 feet of 1/2" flexible conduit may be used for connecting instruments, sensors or associated control components.
- D. Provide outlet boxes in the raceway systems wherever required for pulling wires and cables, making connections, mounting devices, lighting fixtures, controls or connecting miscellaneous equipment. Boxes installed shall be level and flushed mounted within wall cavities/partitions for wall mount devices as noted on plans.
- E. Certain backboxes for the fire alarm systems shall be supplied by the respective equipment suppliers. Any boxes required for the respective systems and not furnished by the respective equipment suppliers shall be furnished and installed. It is this Contractor's responsibility to determine what boxes are and are not furnished by the respective equipment suppliers.
- F. EC to provide all backboxes for Mechanical, HVAC and Plumbing equipment power and/or control devices.
- G. Provide plaster rings as required in gypsum board partitions.
- H. Coordinate box sizes with other equipment supplier as required.
- I. All boxes associated with plastic conduits shall be PVC boxes with cast aluminum covers, complying with NEMA OS2.
- J. Unless otherwise noted, backboxes for telecommunication, technology and security devices shall have extra deep capacity with a minimum size of 4"x4".

1.3 GENERAL

- A. Wherever the terms "conduit" or "raceway" appear hereinafter it shall be understood to mean any one, or combination of, the following type:
 - 1. Rigid Galvanized Steel
 - 2. Electrical Metallic Tubing
 - 3. Flexible Metallic Conduit

4. Square Steel Raceway Duct
 5. Liquid Tight Flexible Conduit with External Wrap Ground Wire
 6. Surface Mounted Raceway
 7. Metal Duct Wireway
 8. Intermediate Steel Conduit
 9. PVC Coated Rigid Steel Conduit
 10. Rigid Non-Metallic Conduit (PVC)
- B. The electrical contractor shall precisely record location of all feeders on legible submitted "As Built" plans at end of project.
- C. Conduits shall not be supported by wire ties. All components including backboxes, pull boxes, panels and the like shall be independently supported from raceway.
- D. Backboxes shall be suitably sized for device mounting, splicing and contain required volume for entering conductors.
- E. Cuts made to metallic supports, equipment or field made conduit threads shall be sprayed with "cold-galvanize" or equivalent rust protection prior to assembly. Electrical contractor shall not leave untreated metal exposed to weather.

1.4 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
1. Maintain required safe working clearances and required dedicated equipment space as defined by the latest edition of National Electrical Code.
 2. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 3. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 4. To allow right of way for piping and conduit installed at required slope.
 5. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.
- C. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping.
- E. Coordinate backbox requirements for technology and telecommunication devices as specified in Division 27.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Rigid Steel Conduit

1. Smooth surfaced heavy wall mild steel tube, of uniform thickness and temper, reamed and machine threaded at each end and protected inside and out with galvanizing, sherardizing, or equivalent process. Rigid steel conduit shall comply with Article 344 of NEC.
2. Non permitted usage:
 - a. Hazardous or corrosive environments.

B. Electrical Metallic Tubing (EMT)

1. Smooth surface, thin wall, mild steel tube, of uniform thickness and temper, galvanized or sherardized on the outside, and enameled on the interior. EMT shall comply with Article 358 of NEC.
2. Non permitted usage:
 - a. Poured concrete.
 - b. Exposed to weather.
 - c. Underground.
 - d. Exposed in mechanical or similar equipment rooms below 8ft from finish floor.
 - e. Hazardous or corrosive atmosphere.

C. Flexible Metallic Conduit

1. Interlocking single strip, steel construction, galvanized inside and out, after fabrication. Conduit shall comply with Article 348 of NEC.
2. Allowed usage:
 - a. Connection to lighting fixtures not over 3 feet in length.
 - b. Narrow movable partitions where other raceways are not practical, when approved by Owner's representative.

D. Steel Square Raceway Duct

1. Square raceway duct shall be 4 x 4 inch minimum or sized as shown on plan. Duct shall be primed and finished gray baked enamel. Duct shall conform to Federal Specifications and have a hinged access cover on one side. Properly support from building. Complete with all necessary fittings.

E. Liquid Tight Flexible Conduit With Exterior Spiral Wound Ground Wire

1. Raceway with a circular cross-section having an outer liquid tight, non-metallic, sunlight-resistant jacket over an inner flexible metal core. Conduit shall comply with Article 350 of NEC.
2. Allowed usage:
 - a. Connection to motors, controllers or panels located on dynamic equipment and transformers. All motor connections shall be water and dust tight with grounding lug fittings approved for wet location usage. Maximum length: 3 feet.

F. Surface Mounted Raceway

1. Surface mounted raceways shall be used only where existing block, existing concrete or other approved existing conditions preventing a concealed installation with sizes required by the National Electrical Code. Raceways shall be totally enclosed and shall be complete with sectional barriers, connectors, fittings, bridges, couplings, conduit adapters, clips, hangers, transition fittings and required device plates for a complete installation.

2. Surface mounted raceways shall be of one manufacture with finish and construction type of ivory unless noted otherwise.
3. Any unused openings to be closed by the Electrical Contractor with blank faceplates.
4. Raceways shall be installed in a neat and symmetrical manner using mechanical fasteners. Feeds to raceways shall be concealed in walls, unless prohibited by wall construction. Installation shall comply with Article 386 of NEC.

G. Metal Duct Wireways

1. Wireways shall be used only where indicated with usage for mounting groups of switches and/or starters. Wireways shall be the standard manufactured product of a company regularly producing wireway and shall not be a local/remote shop-assembled/fabricated unit.
2. Wireways shall be of screw or hinged-cover types, UL listed, and of sizes indicated or otherwise required by the NEC. Finish shall be light-gray enamel over rust inhibitor.
3. Wireways installed in interior spaces shall be NEMA 12 or 3R if installed in an exterior environment.
4. Wireways shall be routed, provided with all necessary components and sized by the Electrical Contractor to accommodate all cables and wires per NEC.

H. Intermediate Steel Conduit

1. Smooth surface, intermediate wall, mild steel tube, of uniform thickness and temper, threaded at each end, and protected inside and out with galvanizing or equivalent process. Conduit shall comply with Article 342 of NEC.
2. Non permitted usage:
 - a. Hazardous or corrosive environments.

I. Rigid Non-Metallic Conduit (PVC)

1. Rigid non-metallic conduit shall be designed for installation below ground and with or without concrete encasement. Rigid non-metallic conduit shall comply with Article 352 of the NEC.
2. Limited usage:
 - a. In or under concrete slabs on grade.
 - b. Exterior use when encased in 3 inch concrete.

J. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

K. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

L. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

M. Outlet boxes specified herein refer generally to cast or pressed steel boxes of less than 50 cubic inch internal volume per gang. Refer to "Junction and Pull Boxes" for larger box specifications.

N. Outlet boxes where exposed to water or weather shall be approved for this use and shall be made of cast iron.

O. All exterior outlet boxes shall be watertight and dust tight with hinged gasketed covers similar to Thomas & Betts "WTD" Series, Crouse-Hinds or TayMac for two (2) GFCI outlets with integral lock and shall be cast aluminum and

threaded for rigid conduit similar to Thomas & Betts "LT" Series. There must be a gasket between the enclosure and the mounting surface and between the hinge cover and the mounting base plate. Enclosure shall be marked "UL listed" and "Suitable for wet locations while in use".

2.2 ACCEPTABLE MANUFACTURERS

- A. Rigid Steel Conduit: O-Z/Gedney, Wheatland Tube, Allied Tube and Conduit.
- B. Intermediate Steel Conduit:, O-Z/Gedney, Wheatland Tube, Allied Tube and Conduit.
- C. Electrical Metallic Tubing: O-Z/Gedney, Wheatland Tube, Allied Tube and Conduit. Steel compression type only, concrete tight with non-insulated throat.
- D. Flexible Metallic Conduit: ACME, International, Electri-Flex
- E. Flexible Conduit, Liquid Tight: Anaconda "Sealtight," National Electric, Coleman Cable and Wire Company.
- F. Steel Square Raceway Duct: Square D, Hoffman Engineering Company, Cooper B-Line.
- G. Surface Mounted Raceway: Wiremold v700 series "ivory" or dual channel non-metallic 5400 series, "white" (unless noted otherwise within Contract Documents), Siemon or Panduit Corp.
- H. Wireways: Hoffman, Hammond Manufacturing, Panduit or approved equal.
- I. PVC coated rigid steel conduit; Occidental Coating Company, Robroy Industries, or equal.
- J. Rigid Non-Metallic Conduit (PVC): Allied, Cantex, Prime Conduit
- K. Pressed Galvanized Sheet Steel Boxes: Appleton Electric, Bowers Manufacturing Company, Steel City, or equal.
- L. Cast Iron Boxes: Crouse Hinds, Appleton, Thomas & Betts, or equal.
- M. Outlet boxes manufactured to provide mounting for special devices are specified with the product affected.
- N. Outlet boxes for nonmetallic conduit: Carlon Electric Sciences, Inc.
- O. PVC coated outlet boxes; Occidental Coating Company, Robroy Industries, or equal.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, non-corrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 USE

- A. The following shall be used as a minimum guideline for the installation of raceways:
 - 1. In metal stud and masonry walls:
 - a. Electrical Metallic Tubing (EMT).
 - b. Intermediate Steel Conduit (IMC).
 - c. Rigid Steel Conduit.
 - 2. Above plaster, drywall, lay-in and furred ceilings:
 - a. Electrical Metallic Tubing (EMT).
 - b. Intermediate Steel Conduit (IMC).

- c. Rigid Steel Conduit.
3. Where exposed in dry locations:
 - a. Electrical Metallic Tubing (EMT).
 - b. Intermediate Steel Conduit (IMC).
 - c. Rigid Steel Conduit.
4. Where exposed in dry locations of storage rooms, mechanical equipment rooms, electrical equipment rooms, etc.
 - a. Intermediate Steel Conduit (IMC).
 - b. Rigid Steel Conduit.
5. Feeders and service entrances encased in concrete:
 - a. Rigid Steel Conduit.
 - b. Rigid Non-Metallic Conduit (PVC).
 - c. Rigid Poly-Vinyl Chloride (PVC) Coated Steel Conduit.
6. Branch circuits in direct contact with earth.
 - a. Rigid Steel Conduit.
 - b. Rigid Non-Metallic Conduit (PVC).
 - c. Rigid Poly-Vinyl Chloride (PVC) Coated Steel Conduit.
7. Where installed in non-conditioned type areas such as parking garages, transformer vaults, loading docks, etc.:
 - a. Rigid Steel Conduit. (RSC).
 - b. Rigid Poly-Vinyl Chloride (PVC) Coated Steel Conduit.
8. All interior feeders in excess of 600 volts:
 - a. Rigid Steel Conduit (RSC).
9. In short lengths (not to exceed 3'-0") for final connections to equipment subject to vibration:
 - a. Flexible Metallic Conduit.
 - b. Liquidtight Flexible Metallic Conduit (Sealtight).
10. In locations where structural or existing conditions prevent the use of rigid conduit, intermediate metallic conduit or electrical metallic conduit. (In cases where flexible conduit is used, prior written approval of the Owner's representative shall be required):
 - a. Flexible Metallic Conduit.
11. Where exposed to weather on rooftops, sides of buildings, etc.:
 - a. Rigid Steel Conduit (RSC).
 - b. Rigid Non-Metallic Conduit (PVC).
 - c. Rigid Poly-Vinyl Chloride (PVC) Coated Steel Conduit.
12. In short lengths for final connections (not to exceed 3'-0") to equipment subject to vibration and exposed to oil or moisture.
 - a. Liquidtight Flexible Metallic Conduit (Sealtight).

13. For connections (not to exceed 3'-0") to kitchen equipment, lab equipment, etc.
 - a. Liquidtight Flexible Metallic Conduit (Sealtight).
14. Branch circuits in direct contact with earth and under roadways.
 - a. Rigid Steel Conduit encased in concrete.
 - b. Rigid Non-Metallic Conduit encased in concrete.
 - c. Rigid Polyvinyl Chloride (PVC) coated steel conduit encased on concrete.
15. Use 3/4 inch minimum trade size conduit unless otherwise noted or specified. In any case, use conduit of sufficient cross section to prevent insulation damage by abrasion and deformation during pulling.
16. Use rigid non-metallic conduit from SPD to building system ground.

3.2 INSTALLATION

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- B. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- C. The actual runs and locations of conduit, lines, and equipment shall be determined on the site and shall be installed to meet the various conditions at the building. Any changes necessary to conceal conduit or clear existing pipes, equipment or construction shall be made.
- D. Do not reduce conduit sizes where indicated as larger than required by Code for conductors indicated to be installed. Electric design may have over-sized raceway to permit future added conductors.
- E. Raceways shall be installed plumb, level, parallel or right angles to nearby surfaces or structural steel following surface contours as much as possible. Use insulating bushing to protect conductors when joining raceways with fittings designed and approved for that purpose. Joints shall be made wrench tight.
- F. Support individual conduit 1 inch and smaller by securing with one-hole malleable iron or pressed steel type straps. Use screws and inserts on concrete or masonry construction, approved clamps or clips on steel construction, or other approved means.
- G. Attach conduit larger than 1 inch to framing members, using approved split ring pipe hangers or 2-hole malleable iron or pressed steel straps.
- H. Use 3/8 inch minimum hanger rod for 2 inch and smaller individual conduit support and 1/2 inch rod for larger individual conduit support. Use preset concrete inserts to support hanger rods. Where inserts are required after placement of concrete, use expansion shield type anchors.
- I. Do not use perforated plumbers tape to support conduit.
- J. Use beam clamps of steel, cadmium-plated or galvanized for attachment to beams and columns.
- K. Do not employ running threads for conduits.
- L. Cut ends square, ream and shoulder in fittings.
- M. Provide conduit expansion fittings at building expansion joints, where necessary to compensate for thermal expansion and contraction or where continuous conduit runs exceeds distances as recommended by manufacturer.

- Metal raceways shall remain electrically continuous by means of approved bonding jumpers where expansion fittings are used.
- N. Install conduit and tubing in a manner which shall not trap moisture due to coupling leakage or condensation. Make conduit joints in earth, concrete, masonry, or exposed on exterior, gas tight.
- O. Conduit shall be supported at intervals of not more than 10 feet or as otherwise required by National Electrical Code. Flexible steel conduit shall be supported at intervals of not more than 3 feet. No conduit or outlet boxes shall be attached to ductwork, piping, or mechanical equipment, unless specifically approved. Support 1-1/4 inch and smaller size within 18 inches of outlets, and 1-1/4 inch or larger sizes within 36 inches of terminations. Do not support conduit from ceiling suspension systems, except that short lengths of flexible conduit for lighting fixture connections may be so supported.
- P. Use cast metal boxes and cast metal fittings for right angle direction changes and for tee, or cross-connections for exposed conduit except where pressed steel boxes are permitted by this Specification. Use factory elbows or field bends only when approved to fit job conditions.
- Q. Do not install bends visibly deformed from true circular cross-section. Make field bends with conduit hand or power bender. Minimum bending radius for power, lighting, and the fire alarm shall be as required by Code.
- R. Minimum bending radius for telephone and data shall be:
1. Not less than 10 times diameter for conduit 2-1/2 inches and larger.
 2. Not less than 20 times diameter for conduit 2 inches and smaller.
- S. Clearance from all mechanical piping including steam, gas, refrigeration, hot water, chilled water, etc., shall not be less than 6 inches and 4" from cross piping.
- T. Conduits to motors in Mechanical Equipment Rooms shall run exposed.
- U. Exposed conduits shall be plumb, level, parallel with or at right angles to building line, beams, or ceilings. Symmetrical bends or metal boxes shall be placed at changes in direction or taps. Positively no conduit shall be run exposed on the exterior face of building unless otherwise pre-approved by the Architect.
- V. Conduit terminals at boxes, cabinets, and in general to wiring enclosures, shall be rigidly secured with double locknuts and bushings or approved fittings. Conduits shall be screwed in and shall engage at least five threads in hub where conduit boxes with threaded hubs are used. Insulating bushings shall be used for conduits 1-1/4 inch or larger, and for conductors larger than 10 AWG, and in cases where wiring is subject to vibration.
- W. Provide independent support for conduit rising from floor for motor connection if over 24 inches above floor. Do not support to a motor or ductwork which may transmit vibration.
- X. Close ends and openings against entry of construction debris, until access is required for installation of conductors or pull wires.
- Y. Do not install across ventilation openings or other foreign systems in electrical clearance areas as specified in NEC Article 110.26.
- Z. All wiring, unless otherwise noted, shall be installed in rigid metal conduit, intermediate metal conduit or EMT as outlined in this specification and subject to the restriction of the NEC. Minimum size raceways shall be 1/2 inch unless otherwise noted or specified. In any case, use conduit of sufficient cross section to prevent insulation damage by abrasion and deformation during pulling.
- AA. All surface and flush mounted panelboards shall have a minimum of six (6) 1" diameter conduits stubbed to nearest accessible ceiling location.
- BB. Empty conduit runs shall have heavy nylon, polypropylene or monofilament pull cord with not less than 200 lbs. tensile strength. Leave at least 12" of slack at each end of pull cord tied to end of each raceway.

- CC. Field bend non-metallic conduit in accordance with the manufacturer's recommendations using heater and bending devices designed and approved for the purpose. The use of torches or other flame-type devices shall not be permitted. Use internal bending plugs on 2 inch conduit and larger to prevent crimping.
- DD. To make joint in non-metallic conduit, use Solvent Cement as recommended by the conduit manufacturer. Be sure conduit ends are clean, dry, and cut at the right angle to the centerline of the conduit. Apply coat of Solvent Cement the length of the socket to be attached. Push conduit firmly into fitting while rotating conduit slightly about one-quarter turn to spread cement evenly. Allow joint to set before proceeding.
- EE. Vertical conduits through floor slabs shall be through sleeves sealed with DOW "RTV" or "Chase Foam". Sleeves shall extend 1" above the finished floor. Multiples of conduit risers may be run through floor openings with concrete or metal curbs of 4 inches in height and closed with insulated fire proofing steel plates. Seal water and moisture tight all conduits entering from outside the building to a conditioned space.

3.3 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors (2 inches) above finished floor level.
- G. Size pipe sleeves to provide (1/4-inch) annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
- I. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work. Roof mounted equipment shall have conduit routed to the equipment within the equipment curb where possible. If a roof penetration must be made, it shall be installed with a pipe seal flashing kit designed for the purpose.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.4 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use 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.

3.5 UNDERGROUND WORK

- A. Underground work shall include excavating, concrete envelopes, raceways, cables, and backfilling required under this Contract unless noted otherwise. The Electrical Contractor shall be responsible for clearing new and/or existing underground service lines such as gas, water service, sanitary and storm water piping. Excavation shall be as set forth under "Special Conditions/Requirements." Excavations shall be properly barricaded and protected to protect persons from injury. Follow rules of authorities having jurisdiction for safety standards. Excavation shall be on an unclassified basis.
- B. Trench excavations shall be made open to proper alignment and grade. Trenches shall be of sufficient width to provide free working space on each side of the raceway structure for concrete envelope forms if required. In earth excavation, the trench shall be carried to a point 6 inches below the bottom of the structure envelope. Raceway structures shall not be allowed to rest directly upon rock, but shall be cushioned by a 6 inch layer of selected crushed stone or gravel. The on-site Owner's representative shall govern the number of points at which the Contractor shall be permitted to work and the length of continuous open trench.
- C. Raceways shall be firmly supported above the trench bed and separated from each other by means of approved spacers installed at intervals not exceeding 5 feet.
- D. Raceway banks shall be encased in minimum of 3000 PSI concrete envelope not less than 3 inches thick all around the outside limits of the raceway group. In all instances, the concrete shall be not less than 3 inches between any surfaces of a raceway. Underground structures shall be so installed that the top of the enclosing concrete envelope shall not be less than 30 inches below finish grade or otherwise required by code or local AHJ's. Exiting of raceways from concrete slab shall be made with rigid galvanized steel elbows.
- E. Concrete envelopes shall be reinforced at points where they cross fill or loose soil, foreign piping, or under vehicular roadways. Reinforcing shall be of size and extent indicated within Contract documents and shall extend 6 feet beyond each limit of fill, roadway, and/or foreign pipe. Where excavation for building purposes is below required grade for duct and manholes, and fill is to be placed under another contract, the Electrical Contractor shall be responsible for determination of satisfactory bearing conditions, and construct in accordance with preceding requirements.
- F. Excavations shall be backfilled to finished grades. Backfill shall consist of screened excavated materials approved for backfilling consisting of earth, loam, sandy material, soft shale, or other approved materials, free from large clods of earth or stone. Backfill shall be brought up on approximately 6 inch layers and compacted. Any trenches improperly backfilled or where settlement occurs shall be reopened to the depth required for proper compaction, then refilled and compacted. Refer to Division 3 "Concrete" and Division 31, "Earthwork" for backfill and compaction requirements.
- G. Open trenches under roadways or paved areas shall be backfilled as specified above, except that the entire depth of trench shall be backfilled in 6 inch layers, each layer moistened and compacted to a density at least equal to that of the surrounding earth and in such manner as to permit rolling and compaction of the filled trench together with the adjoining earth to provide the required bearing value so that paving of the area can proceed immediately after backfilling is completed.
- H. Identification for conduits for medium voltage feeders.
 - 1. Provide self adhesive or painted sign reading "HIGH VOLTAGE" red on white, size ½ height of conduit diameter.

2. Signs shall be provided at 20 foot intervals on accessible conduits and on armored cable in cable trays.

3.6 OUTLET BOXES

- A. Do not install boxes smaller than permitted by National Electrical Code. Where no outlet box size is indicated or specified, install a box of not less than 4 inches square by 1 1/2 inches deep dimensions. In dry locations, use pressed galvanized steel boxes, with drilled and tapped ears, and manufacturer's pre punched knockouts. In wet locations, for exposed interior locations below 4 feet above floor, and where poured into exterior concrete, use cast metal boxes with threaded hubs.
- B. Provide pressed steel outlet boxes with tile ring where installed in brick, tile, marble, and similar material and in masonry block walls. Equip with plaster rings where plaster or drywall finish is indicated. Select rings of proper depth to place front of ring even with the plane of the finish surface. Select style of ring to match device and finish plates to be installed. Boxes shall be installed plumb, level and flush with wall surface.
- C. Close unused openings in pressed steel boxes with knockout closure and in cast boxes with threaded plugs.
- D. Gaskets for cast metal boxes may be omitted where installed in dry locations.
- E. Use concrete type boxes where required to clear and not displace reinforcement.
- F. Use multiple gang boxes for grouping devices at one location. Provide barriers between different systems and between adjacent devices when the voltage between adjacent exposed live parts exceeds 300 volts to ground.
- G. Support ceiling outlet boxes flush with the ceiling plane. Use approved bar hanger or other approved means to provide adequate support for lighting fixtures or other products attached to ceiling outlet boxes. Equipment boxes with fixture studs where required by the lighting fixtures to be installed. Support boxes in suspended ceiling systems from main runner channels, or joists or other structural members. Do not support from the ceiling suspension system support wires or tile support tees or similar light weight ceiling components, unless the components are designed and approved for this purpose.
- H. Provide outlet boxes used as junction boxes with blank device plates if installed flush, and with blank galvanized covers if installed on the surface. Use raised covers on surface boxes in finished areas. Flat plates may be used on surface boxes in machine rooms, electrical rooms, and similar unfinished areas.
- I. Provide outlet boxes with bushed cover plates where used for systems requiring an exposed cable connection from the box.
- J. Locate outlet boxes so that they shall be readily accessible. Boxes over suspended ceiling systems are considered readily accessible if the ceiling tile removal permits ready access to such boxes.
- K. Use PVC coated junction boxes in conjunction with PVC coated rigid steel conduit and fittings.
- L. Individual circuits are shown on plans for clarity. Branch circuit "home runs" maybe grouped together (unless noted otherwise) and extended to panels as shown.

3.7 FLOOR BOXES

- A. Provide box with protective removable concrete cover. Pour and trowel concrete so cover is flush with concrete. Remove cover after concrete is set and adjust box flush with final floor surface. Where installed in "other" floor types box shall be fully supported and secured with final assembly matching surface of finish floor. Installation of floor box must conform to manufacturer's specifications and shall be flush with final floor finish. Box type and configured service ports as specified in Section 262726 "Wiring Devices".

3.8 PROTECTION

- A. Provide final protection and maintain conditions that ensure coating, 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 manufacture.
- B. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacture.

END OF SECTION 260533

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SECTION 260534 - JUNCTION & PULL BOXES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions, General Requirements and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION

- A. Provide junction and pull boxes in accordance with Contract Documents. Wherever possible, use outlet boxes for junction and pull boxes. Fuses in equipment shall be furnished by the respective contractor supplying the device and installed under this Division.
- B. Provide cabinets in accordance with the Contract Documents. Cabinets for same type of use shall be the product of a single manufacturer. Do not install surface mounted cabinets in finished areas, unless indicated. Where conflicting data is indicated, verify mounting requirements prior to ordering cabinets.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Sheet Steel Junction and Pull Boxes: Hoffman, Hammond Mfg, Steel City or approved equal.
- B. Cast Iron Junction and Pull Boxes: O.Z. Electric Manufacturing Company, Crouse Hinds Company, or equal.
- C. Rigid Nonmetallic Junction and Pull Boxes: Carlon Electric Sciences, Inc. Hubbell, Cantex Industries or equal.
- D. Underground Junction Boxes: Quazite Incorporated or approved equal.
 - 1. Junction or hand-hole boxes shall be “Tier-15” rated and installed to withstand all loads likely to be imposed meeting the requirements of 2011 NEC, ANSI/SCTE 77-2002 and UL. Underground box shall be NEMA 4 constructed of non-corrosive polymer concrete and reinforced by a heavy weave fiberglass. Cover shall be gasketed and recessed cover bolts shall be stainless steel. Cover shall be flush with sidewalk, landscaping or surrounding surface. Cover logo shall say reflect contents such as “COMMUNICATION”, “ELECTRIC” or as noted within Contract documents. Box shall be ribbed externally and internally for rigidity, shall be able to be drilled to accept mounting brackets without impairing strength. Cover and box shall be ultraviolet protected. Conduits shall enter bottom of lower unit using a long-sweeping ell fitting.
- E. Cabinets: Products of the following manufacturers are acceptable. Other products shall be approved as equal.
 - 1. Cabinets for General Use: Hoffman Engineering Company, Hammond Manufacturing, or equal.
 - 2. Cabinets for systems and/or products, use cabinets furnished by manufacturer with system or product. Where system or product cabinets do not comply with these specifications, submit cabinet shop drawings, indicating deviations, and obtain approval for their use.

2.2 MATERIALS

- A. Fabricate sheet metal junction and pull boxes of galvanized, Code gauge, sheet steel. Include angle iron framing where required for rigidity. Boxes shall not deflect or deform when covers are removed after conduit and conductors are installed, and any deflection occurring shall not prevent the easy installation and removal of cover attachment screws.

- B. Size junction and pull boxes to not less than minimum National Electrical Code requirements. Increase size above Code requirements where necessary to provide space for pulling, racking, or splicing enclosed conductors, or where specified or indicated dimensions exceed Code requirements.
- C. Metal junction and pull boxes exposed to weather shall be listed for use such as (and not installed in or below grade) raintight, weatherproof or waterproof. Boxes shall contain gaskets with removable covers. Use boxes constructed to meet NEMA 3R requirements or otherwise noted or required by code. Equivalent gasket boxes or boxes of similar design permanently rendered weatherproof. Raintight or weatherproof boxes shall use threaded watertight hubs for top or side entry and may use knockout for bottom entry only. For exterior pull boxes, use a minimum of 14 gauge galvanized sheet steel. Apply galvanizing by the hot dip process after fabrication.
- D. Surface sheet metal junction and pull boxes with covers aligning with the sides of the box and equip flush boxes with covers extending 3/4 inch all around the perimeter of the back box. Provide sufficient cover attachment screws to ensure that box covers contact the surface of the box for the entire perimeter of the enclosure. Use brass or stainless steel screws to attach covers to boxes.
- E. Use brass screws only to attach junction and pull box covers to interior floor boxes or boxes located where moisture may be present.
- F. Do not use single covers for junction and pull boxes having cover length or width dimension exceeding 3 feet so specified, indicated, or approved. Sectionalize covers that exceed 3 feet in either dimension into two or more sections.
- G. Provide barrier between pull boxes for cables of different voltage and to separate cables connected to the emergency and normal power.
- H. Provide split or hinged covers on junction/pull boxes when the cover exceeds eight (8) square feet in area.
- I. This contractor shall paint all fire alarm system junction boxes, pull boxes and covers in red paint in accordance to Ohio Building Code.
- J. Indoor Cabinets:
 - 1. Construct of cold rolled quality steel, with metal gauges and construction methods conforming to National Electrical Code requirements, and Underwriters' Laboratory standards.
 - 2. Finish doors, trims, and back boxes for surface mounted cabinets in finished areas, by applying a rust resistant treatment, prime coat, and a final coat of manufacturer's standard enamel or lacquer finish. Galvanize all other sheet metal components of cabinets, excepting non ferrous metal parts, or steel parts provided with cadmium plating or equivalent protective plating.
 - 3. Equip doors with concealed or semi concealed hinges and with flush or semi flush spring catch type flush cylinder locks. Key cabinet doors of similar use alike, and provide two keys with each lock.
 - 4. Set cabinet doors flush into cabinet trim. Equip trim with adjustable clamps or other approved means to fasten trim to cabinets. Fastening method shall permit adjustment for aligning the trim of flush cabinets to a plumb position. Trim for flush cabinets shall extend not less than 3/4 inch beyond the perimeter of the back box.
 - 5. Do not use factory furnished knockouts with surface back boxes. Punch or drill required openings during installation. Equip flush back boxes with manufacturer's standard pattern of knockouts.
- K. Outdoor Cabinets:
 - 1. Cabinets shall be constructed of 12 gauge, Type 304 stainless steel, reinforced as necessary in large sizes.
 - 2. Cabinet shall have gaskets, etc., required to meet NEMA Type 4 and UL 508 requirements.
 - 3. Cabinets shall be of size indicated within Contract documents meeting minimum code requirements plus 25 percent growth.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Locate interior junction and pull boxes in machine rooms, equipment rooms, storage rooms, electrical rooms, and similar utility spaces, unless otherwise indicated or approved. Fasten plates to boxes with countersunk flat head screws. Provide plates with 3/4 inch trim all around.
- B. Do not exceed the equivalent of three 90deg bends between general wiring pull and junction boxes, and reduce to not more than the equivalent of two 90deg bends where telephone or other multi conductor cable shall be installed.
- C. Install junction boxes and pull boxes in a manner to insure that equipment ground continuity is maintained.
- D. Junction and pull boxes shall be accessible.
- E. Boxes shall be installed every 100 feet in major feeders.
- F. Underground junction boxes shall be installed according to manufacturer's instructions.
- G. Support all junction/pull boxes with 1/2 inch all-thread rod from floor above or joists or structural members. If mounted tight to floor above, use approved anchors. Tie wire used to support, suspend, or secure junction/pull boxes is not acceptable.
- H. Cabinets:
 - 1. Set cabinets at heights indicated or specified. In the absence of such information, set cabinets at not to exceed 6 feet 6 inches from finished floor to top of cabinet.
 - 2. Level and align the tops of cabinets in sight of each other at a uniform height.
 - 3. Install cabinets (and other enclosure products) plumb with building construction. Install flush enclosures so that the trim shall rest against the surrounding surface metal around the entire perimeter of the enclosure.
 - 4. Fastenings shall be made by means of not smaller than 3/16 inch diameter bolts, expansion bolts, or toggle bolts; not smaller than No. 9 x 1 inch wood screws. Fastenings, where exposed to weather or moisture, shall be galvanized. Not less than four fastenings shall be used to secure each cabinet. Do not use nails, or wooden fiber inserts in masonry.
 - 5. On masonry or concrete walls, columns or flooring, fastenings shall be made by means of lead expansion shields not smaller than shield size 3/8 inch diameter by 5/8 inch long for use with No.10 24 round head machine screws. Machine screws shall be not less than 1-1/4 inches long for installation on ceiling and not less than 1 inch long elsewhere.
 - 6. Holes for lead expansion shields shall be carefully and accurately drilled, using sharp drills to a depth which shall afford the maximum practical engagement of threads (depth equal to screw length not less than 1 1/4 inches past plaster into solid concrete). Installation shall develop full strength of screws.

END OF SECTION 260534

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SECTION 260535 - RACEWAY & FITTINGS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions, General Requirements, Division 1 Specifications, apply to this Section.

1.2 DESCRIPTION

- A. Provide all raceway fittings, supports and back boxes required to complete work indicated on the Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Subject to general requirements and use as specified in Section 260533 "Raceway and Boxes".
- B. For fittings of specialized type, use the products as scheduled for each type under "Manufacturers," or approved equal.

2.2 MANUFACTURERS

- A. General Use Fittings: Steel City, Thomas & Betts, O.Z. Electric Manufacturing Co., Carlon, Sealing Fittings: Appleton Electric, Crouse-Hinds.
- B. Liquid-Tight Flexible Conduit Fittings: Thomas & Betts, Appleton Electric, Steel City.
- C. Expansion Fittings: O.Z. Type "DX" or approved equal of Appleton, Thomas & Betts, Crouse Hinds.
- D. Cast Metal Straight, Tee, Cross, and Fittings: Crouse-Hinds, Appleton Electric, Killark.
- E. Rigid Nonmetallic Conduit Fitting: Carlon Electrical Sciences, Inc. Cantex Industries, Hubbell.
- F. PVC coated fittings: Occidental Coating Company, Robroy Industries, Ocal (Thomas & Betts) or equal.

PART 3 - EXECUTION

3.1 USE

- A. Use threaded fittings for rigid and intermediate metal conduit.
- B. Compression or drive-on watertight fittings shall be used for metallic tubing. Fittings with set screws for trade size smaller than 2 inch is not approved for use.
- C. Fittings for flexible conduit as approved by the enforcing Code official.
- D. Use fittings made of the same material and corrosion resistance as the raceway except:
 - 1. Malleable iron and steel are interchangeable.
 - 2. Die cast fittings may be used for flexible steel conduit, and for factory manufactured offsets.
 - 3. Use insulated bushings for conduit trade sizes.
 - 4. Use steel insulated throat connectors for electrical metallic tubing.

- E. Use steel fittings that are galvanized, cadmium-plated, or have other approved protective coating.
- F. Use double locknuts for terminating rigid conduit at sheet metal enclosures and equipment conduit ends with bushings.
- G. Provide expansion fittings on every raceway larger than 1-1/2 inches, and use a 2 foot piece of seal tight on all conduit routings 1-1/2 inches and smaller where it crosses any building expansion joints. Expansion fittings shall be provided for conduit thermal expansion or contraction in accordance to tables specified in NEC. Verify exact location of building expansion joints prior to installation of raceway with project Architect.
- H. Where an expansion fitting is used, conduit bonding shall be continuous by means of a flexible braided copper bonding strap with ground clamps. Bonding strap and clamps shall be provided for grounding continuity as required by NEC. Strap shall be of sufficient length to allow full expansion. Manufacturer Crouse-Hinds XJ or XJG-EMT or approved equal.
- I. Use PVC coated fittings for rigid PVC coated steel conduit.
- J. Provide moisture barrier fittings for conduit routing entering conditioned spaces from non-conditioned spaces. This contractor shall fill fitting with an approved material preventing circulation and formations of moisture in the conduit system.
- K. Where conduit is subject to collection of condensation or moisture, provide a low point combination breather/drain such as Crouse-Hinds ECD or equal.

END OF SECTION 260535

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SECTION 260553 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Sections, apply to this Section.

1.2 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Schedule of Nomenclature: An index of electrical equipment and system components used in identification signs and labels.
- C. Samples: For each type of label and sign to illustrate color, lettering style and graphic features of identification products.

1.3 QUALITY ASSURANCE

- A. Comply with ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 - PRODUCTS

2.1 RACEWAY AND CABLE LABELS

- A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
 - 1. Color: Black letters on orange field.
 - 2. Legend: Indicates voltage.
- B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend over-laminated with a clear, weather- and chemical-resistant coating.
- C. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches wide.
- D. Provide conduit labels for voltages greater than 115 volts. Labels to indicate voltage and shall be pre-tension acrylic/vinyl construction coiled to completely encircle conduit diameters through five inches or pre-molded to conform to the circumference of six inch conduits.

2.2 NAMEPLATES AND SIGNS

- A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
- C. Fasteners for Nameplates and Signs: Self-tapping, stainless steel screws of No. 10/32, stainless steel machine screws with nuts and flat and lock washers.

2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength: 50 lb. minimum
 - 3. Temperature Range: Minus 40 to plus 185° F.
 - 4. Color: According to color-coding.
 - 5. Paint: Formulated for the type of surface and intended use.
 - a. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.
 - b. Primer for Concrete Masonry Units: Heavy-duty resin block filler.
 - c. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
 - d. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Lettering, Colors and Graphics: Coordinate names, abbreviations, colors and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout project.
- C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before applying.
- E. Color Banding Raceways and Exposed Cables: Band exposed and accessible raceways of the systems listed below:
 - 1. Bands: Colored adhesive tape. Make each color band 2 inches wide, completely encircling conduit and place adjacent bands of two-color markings in contact, side by side.
 - 2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50 feet maximum intervals in straight runs, and at 25 feet maximum intervals in congested areas.
 - 3. Apply the following colors to the systems listed below:
 - a. Fire Alarm System: Red
 - b. Fire Suppression Supervisory and Control System: Red and yellow
 - c. Mechanical and Electrical Supervisory System: Green and blue
 - d. Telecommunication System: Green and yellow.
- F. 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.

- G. Circuit Identification Labels to be installed internally on backside of wall plates for each wiring device and outlet.
 - 1. Labeling Legend: Permanent, waterproof description of panelboard and branch circuit feeding wiring device or description of source origination (IT Rack, switch, etc).
 - a. Exposed Outlet Boxes: Pressure-sensitive, permanent self-adhesive plastic label on wiring device cover. Installed plumb and level uniformly throughout project.
- H. Color Coding of Secondary Phase Conductors: Use the following colors for feeder and branch circuit phase conductors.
 - 1. 208/120-V Conductors:
 - a. Phase A: Black
 - b. Phase B: Red
 - c. Phase C: Blue
 - d. Neutral: White
 - e. Ground: Green
 - 2. 480/277-V Conductors:
 - a. Phase A: Brown
 - b. Phase B: Orange
 - c. Phase C: Yellow
 - d. Neutral: Gray
 - e. Ground: Green
- I. Factory-apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG.
 - 1. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6" from terminal points and in boxes where splices or taps are made. Apply last two (2) turns of tape with no tension to prevent possible unwinding. Use 1 inch wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
- J. Power-Circuit Identification: Metal tags or aluminum wrap- around marker bands for cables, feeders and power circuits in vaults, pull and junction boxes, manholes and switchboard rooms.
 - 1. Legend: 1/4" steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
 - 2. Tag Fasteners: Nylon cable ties.
 - 3. Band Fasteners: Integral ears.
- K. Apply identification to conductors as follows:
 - 1. Conductors to be extended in the Future: Indicate source and circuit numbers.

2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number and phase. Use color-coding to identify circuits' voltage and phase.
 3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding or cable marking tape.
- L. Apply warning, caution and instruction signs as follows:
1. Warnings, Cautions and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
 2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8" high lettering for emergency instructions on power transfer and other emergency operations.
- M. Fire alarm junction boxes: All fire alarm system junction boxes and cover plates shall be painted red.
- N. Service Equipment:
1. Plaque: Provide directory plaque in accordance to NFPA 70-225.37 where building has more than one service.
 2. Disconnecting Means: Each service disconnect means shall be permanently identified meeting the requirements of NFPA 70-230.70(B).
- O. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes distribution, branch, lighting, communication, signal and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with 1/2" high lettering on 1-1/2" high label; where two (2) lines of text are required, use labels 2" high. Use black lettering on white field. Apply labels for each unit of the following categories of equipment using mechanical fasteners.
1. Panelboards, electrical cabinets and enclosures
 2. Access doors and panels for concealed electrical items
 3. Electrical switchgear and switchboards
 4. Emergency system boxes and enclosures
 5. Automatic transfer switches
 6. Lighting control panels
 7. Motor-control centers
 8. Disconnect switches
 9. Enclosed circuit breakers
 10. Motor starters
 11. Push-button stations
 12. Contactors
 13. Remote-controlled switches

14. Dimmers
 15. Control devices
 16. Transformers
 17. Fire alarm master station or control panel
 18. Variable frequency drives
 19. Manual motor starting switches
 20. Manual operation switches
 21. Dedicated circuits
- P. Panelboard Schedules:
1. Panelboard schedules shall be revised reflecting final alterations, additions and load balancing. Schedules shall include identification of service loads, wattage and/or HP, pole quantity, amperage and shall be type written. Compliance shall be in accordance to NEC article 408.4.

END OF SECTION 260553

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SECTION 260800 – COMMISSIONING OF ELECTRICAL SYSTEMS

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.
- B. Refer to Section 01 91 13 "Commissioning" for all specific requirements required associated with the commissioning process that will be required as part of this work. As part of this project, participation in the commissioning process as described in Section 01 91 13 shall be required.

1.2 SUMMARY

- A. Section includes commissioning process requirements for electrical systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 DEFINITIONS

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.
- D. DDC: Direct Digital Controls.
- E. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 ALLOWANCES

- A. Labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing are covered by the "Schedule of Allowances" Article in Division 01 Section "Allowances."

1.5 UNIT PRICES

- A. Commissioning testing allowance may be adjusted up or down by the "List of Unit Prices" Article in Division 01 Section "Unit Prices" when actual man-hours are computed at the end of commissioning testing.

1.6 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase coordination meetings.
- C. Attend testing review and coordination meetings.
- D. Participate in Electrical systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- E. Provide information requested by the CxA for final commissioning documentation.
- F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.7 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual Electrical systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning testing.
- C. Verify testing, adjusting, and balancing of Work are complete.
- D. Provide test data, inspection reports, and certificates in Systems Manual.

1.8 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Electrical systems, assemblies, equipment, and components to be verified and tested.
 - 4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
 - 5. Certificate of readiness certifying that Electrical systems, subsystems, equipment, and associated controls are ready for testing.
 - 6. Test and inspection reports and certificates.
 - 7. Corrective action documents.
 - 8. Verification of testing reports.

1.9 SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, prestart, and startup activities.

1.10 COMMISSIONING AUTHORITY

- A. Motz Engineering acting in conjunction with the Xavier University will take the role of the Commissioning Authority for this project. The Commissioning Authority will respond to all issues directly to the Owner and shall have the authority to grant final acceptance of each system commissioned.

1.11 COMMISSIONING PLAN

- A. The project Commissioning Plan is included in Section 01 91 13 as a reference for information only. This section and sections in other Divisions shall outline the work required for the project, consistent with the Commissioning Plan. Any discrepancies between the Commissioning Plan and the Project Manual sections shall be brought to the attention of the Commissioning Agent for clarification.

1.12 COORDINATION

- A. All Prime Contractors and appropriate Subcontractors shall be responsible for cooperating and coordinating their work during the installation and commissioning process. Refer to the specific requirements and other sections for required work associated with coordination of installation work and preparation of Coordination Construction Drawings by the contractors.
- B. The Commissioning Authority will participate in the coordination of installation work as necessary to insure the installation of system components meet the Owner's project requirements and will provide a facility that has appropriate access and means for future maintenance and service by Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

- A. Certify that Electrical systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that Electrical instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that testing procedures have been completed and that testing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.

- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING VERIFICATION

- A. Provide technicians, instrumentation, and tools to verify testing of Electrical systems at the direction of the CxA.
 - 1. The CxA will notify Electric Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
 - 2. The Electric Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
 - 3. Failure of an item includes a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing.
 - 4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of Electrical testing shall include entire Electrical installation.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors and the fire alarm system.
- D. Tests will be performed using design conditions whenever possible.
- E. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- F. The CxA may direct that set points be altered when simulating conditions is not practical.
- G. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- H. If tests cannot be completed because of a deficiency outside the scope of the Electrical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- I. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 ELECTRICAL SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. The following Electrical systems shall be commissioned:
 - 1. Lighting Control Systems.

END OF SECTION 260800

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SECTION 260923 - LIGHTING CONTROL DEVICES

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.
- B. Reference specification Division 26 Section 262726 “Wiring Devices”.

1.2 SUMMARY

- A. This Section includes the following lighting control devices:
 - 1. Time switches.
 - 2. Photoelectric switches.
 - 3. Indoor occupancy/vacancy sensors.
 - 4. Lighting contactors.
 - 5. Cover plates: All cover plates shall be stainless steel.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.
- C. US: Ultrasonic.
- D. DT: Dual technology PIR & US

1.4 SUBMITTALS

- A. Product Data Sheet: Submit data sheet(s) for each type of lighting control, sensors, required relays and controllers.
- B. Shop Drawings: Provide installation plan drawing with layouts and details for each room or area having lighting controls. Each drawing shall include location of controls, light fixtures, sensors and other required equipment. Include bill of material identifying products used with cross-reference to product data sheets. Wiring schematics shall be included for each type of control scheme.
- C. Operation and Maintenance Data: Provide for each product used within project shall have operation and maintenance manuals.

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.

1.6 COORDINATION

- 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 system, and partition assemblies.

PART 2 - PRODUCTS (SELECTED TYPES WHERE APPLICABLE)

2.1 INTERIOR DIMMING SWITCHES

- A. Reference specification Division 26 Section 262726 "Wiring Devices".

2.2 TIME SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Area Lighting Research, Inc.; Tyco Electronics
 2. Intermatic, Inc
 3. Leviton Mfg. Company Inc
 4. TORK. Plate, Inc.
 5. Hubbell Automation
 6. Watt Stopper
- B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.
1. Contact Configuration: DPDT
 2. Contact Rating: 30A ballast load, 120/240-V AC
 3. Program: 2 on-off set points on a 24-hour schedule.
 4. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
 5. Astronomic Time: All channels.
 6. Battery Backup: For schedules and time clock.
- C. Electromechanical-Dial Time Switches: Type complying with UL 917.
1. Contact Configuration: DPDT
 2. Contact Rating: 20-A ballast load, 120/227V AC.
 3. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
 4. Astronomic time dial.
 5. Eight-Day Program: Uniquely programmable for each weekday and holidays.
 6. Skip-a-day mode.
 7. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 8 hours.

2.3 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Area Lighting Research, Inc
 2. Intermatic, Inc
 3. Lithonia Lighting
 4. TORK
 5. Hubbell Automation
 6. Watt Stopper

- B. Description: Solid state, with DPST dry contacts rated for 1800-VA tungsten to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
 - 1. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range.
 - 2. Time Delay: 15-second minimum, to prevent false operation.
 - 3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.

- C. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.4 INDOOR OCCUPANCY/VACANCY SENSORS

- A. It's the responsibility of the Electrical Contractor to ensure that sensors meet or exceed the specifications included herein. Sensors and their subcomponents shall operate as intended and under load conditions as shown within Contract documents.
 - 1. Building Codes: All units shall comply with applicable, local building codes.
 - 2. All sensors shall be FCC compliant where applicable.
 - 3. Manufacturer shall 100% test all equipment prior to shipment. Sample testing is not acceptable.
 - 4. UL listed having standard warranty of 5 years.
 - 5. This contractor shall provide low voltage communication cable (type per manufacturer specification) from low voltage sensor to remote power pack or fixture per installation details. Cable shall be rated for plenum use.
 - 6. Controls shall be recessed to limit tampering and provide user adjustable settings for time delay and sensitivity.
 - 7. All office & classroom area will require occupancy sensor relay for connection to the HVAC. Refer to Lighting & mechanical drawings.
 - 8. Refer to lighting control diagrams for dimming requirements.

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Watt Stopper
 - 2. Sensor Switch
 - 3. Hubbell Building Automation
 - 4. Cooper Controls

- C. Submittals:
 - 1. Bill of Materials: Complete list of all parts needed to fully install selected occupancy sensors.
 - a. Product Data: Submit product data, including catalog cut sheets for specified products.
 - b. Shop and Wiring Drawings: Submit shop drawings detailing all mechanical and electrical equipment including one-line diagrams, wire counts, coverage patterns, and physical dimensions of each item.

 - 2. Documentation & Commissioning
 - a. Field terminations shall be identified indicating wire originations. Point-to-point wiring diagram shall be provided and shall include "As-Built" conditions. Submit in duplicates to Owner and Project Architect.

- b. EC shall provide System Manufacturer on-site configuration and programming of lighting system. EC to provide training of Owners representative.
 - c. Fixture Compatibility: List of ballasts and lamp combinations compatible with occupancy sensors, by manufacturer and catalog number.
 - d. Control cabling specifications.
3. Low Voltage Switch Requirements
 4. The programming for the digital switch shall reside in the switch itself and shall communicate to system components via RS 485. Switches shall provide capabilities to be locally programmed. Each individual switch button being programmed for On only, Off only.
 5. Switches installed shall be rated for high abuse areas and shall be vandal resistant, contain no moving parts, and be touch sensitive and available with up to three buttons in a single gang.
 6. Low voltage switch plates to be stainless steel.
- D. Switches must be capable of handling electrostatic discharges of at least 30,000 volts (1cmspark) without any interruption or failure in operation
- E. Wall Switches:
1. Switch shall be rated at 120/277V in one unit with no minimum load requirements.
 2. Cover plates to be stainless steel.
 3. Walk through feature shall shut off lights within 2.5 minutes after momentary occupancy.
 4. Automatically adapt to changing room conditions—with the ability to disable adaptive features.
 5. Shall save learned and adjusted settings in non-volatile memory that retains all settings during power outages.
 6. Maximum adapted time-out shall not exceed 30 minutes.
 7. Switch sensor shall utilize PIR, ultrasonic or by combining both sensing technologies pending application of switch.
 8. Dual operation: Automatic - on/off and manual on/off or automatic only operation.
 9. Zero point switching.
 10. Shall have a 3-position service switch: off, auto, and on when configured for dual operation or no switch for automation only operation.
 - a. Single circuit
 - 1) Shall recognize motion detected within 20 seconds of turning off lighting as a false off. In response to a false off, the microprocessor shall increase the time-off setting.
 - 2) Rating: 1800W/VA @ 120V, 4000VA @ 277V, and 1/4HP @ 120VAC.
 - b. Dual Circuit
 - 1) Shall provide switching for 2 separate banks from a single unit.
 - 2) Shall offer two modes of operation:
 - a.) Only one relay responds to photocell.
 - 3) Both relays respond to photocell and lights return to the previous state on the next cycle.
 - 4) Ratings: Primary Relay - 800W @ 120V, 1200VA @ 120V, 2700VA @ 277V @ 120VAC; Secondary Relay - 800W @ 120V, 800VA @ 120V, 1200VA @ 277V.

11. Unless otherwise noted within contract documents, the Electrical Contractor shall provide wall occupancy switches with the minimum features:
 - a. Dual sensor technology
 - b. Single circuit
 - c. Automatic and Manual operation
 - d. Shall meet other requirements of project documents.
12. The Electrical Contractor, as part of the work of this section, shall coordinate, receive, mount, connect, and place into operation all occupancy related equipment. The Electrical Contractor shall furnish all conduit, wire, connectors, hardware, and other incidental items necessary for properly functioning lighting control and occupancy sensors as described herein and shown within contract documents. The Electrical Contractor shall maintain performance criteria stated by manufacturer without defects, damage, or failure.

F. Ceiling Occupancy/Vacancy Sensors

1. Shall use microprocessor for motion signal analysis and internal, adaptive self-adjustment. Shall automatically adapt to changing room conditions.
2. Shall identify, record and learn a room's normal occupancy cycles to automatically adjust the sensitivity threshold.
3. Shall save learned and adjusted settings in non-volatile memory that retains all settings during power outages.
4. Shall accept Class 2 wiring.
5. Shall mount on the ceiling.
6. Shall provide a concealed bypass switch to force on lighting.
7. Shall save learned and adjusted settings in non-volatile memory that retains all settings during power outages.
8. Shall be equipped with tamper resistant cover.
9. All controls shall be accessible from front of unit.
10. Rugged, plastic housing shall be available in white.
11. Shall incorporate a real-time motion indicator LED, which is visible from the front of unit.
12. Provide white ceiling mount occupancy sensors with accessories and required components as specified within Contract documents by one manufacturer. All color choices shall be confirmed with Architect.
 - a. Dual Sensor
 - 1) Shall incorporate Doppler shift ultrasonic and passive infrared motion detection technologies.
 - 2) Shall be available in 360° coverage patterns. Infrared lenses shall have a 360° field of view.
 - 3) Sensor shall have two modes of operation:
 - a) Multi-technology mode: where the sensors send infrared signal to the microprocessor, which makes the decision to turn on lighting based on the level of the signal.
 - b) Single technology mode: where the user chooses technology that will turn on lighting.
 - 4) Shall have mask inserts for PIR rejection to prevent false tripping.
 - b. Single Sensor - Ultrasonic
 - 1) Shall utilize Doppler shift ultrasonic detection technology.

- c. Single Sensor – PIR
 - 1) Shall utilize passive infrared motion detection.
 - 2) Shall automatically adapt to changing background PIR levels.
 - 3) Infrared lenses shall have 360° field of view.
 - 4) Shall have mask inserts for PIR rejection to prevent false tripping.
- 13. Wall Switch Sensors
 - a. Provide a white wall mount occupancy switch by one manufacturer. All color choices shall be confirmed with Architect prior to ordering.
 - 1) Sensor Switch
 - 2) Hubbell
 - 3) Cooper Controls
 - 4) Watt Stopper
 - b. Wall switch sensors shall recess into single-gang switch box and fit a standard GFI opening.
 - c. Wall switch sensors shall have optional features for photocell/daylight override, vandal resistant lens, and low temperature/high humidity operation.
 - d. Wall switch sensors shall be stainless steel.
 - e. Wall switch sensors shall be the following Sensor Switch model numbers, with device color and optional features as specified:
 - nWSD (PIR, 1 Relay)**
 - nWSD PDT (Dual Technology, 1 Relay)**
 - nWSD 2P (PIR, 2 Relays)**
 - nWSD PDT 2P (Dual Technology, 2 Relays)**
 - nWSD NL (PIR w/ Night Light, 1 Relay)**
 - nWSD PDT NL (Dual Technology w/ Night Light, 1 Relay)**
 - nWSD LV (PIR, No Relay)**
 - nWSD PDT LV (Dual Technology w/ Night Light, No Relay)**
- 14. Line-Low Voltage Power Pack
 - a. Shall be compatible with incandescent, magnetic or electronic low voltage, and magnetic or electronic fluorescent, as well as motor loads.
 - b. Relay function shall not require more than 5-ma control current to operate.
 - c. Shall be installed inside a standard 4" x 4" junction box.
 - d. Ratings:
 - 1) 20A incandescent, 20A fluorescent @ 120vAC, 20A fluorescent @ 277vAC
 - 2) HVAC Relay – SPDT 500ma@24VDC three-wire isolated. Ratings: 0.5A, 125VAC; 1A, 30VD
- 15. The Electrical Contractor, as part of the work of this section, shall coordinate, receive, mount, connect, and place into operation all occupancy related equipment. The Electrical Contractor shall furnish all conduit, wire, connectors, hardware, and other incidental items necessary for properly functioning lighting control

and occupancy sensors as described herein and shown within contract documents. The Electrical Contractor shall maintain performance criteria stated by manufacturer without defects, damage, or failure.

2.5 LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Allen-Bradley/Rockwell Automation
 - 2. ASCO Power Technologies
 - 3. Eaton Electrical Inc.; Cutler-Hammer Products
 - 4. GE Industrial Systems; Total Lighting Control
 - 5. Square D; Schneider Electric
- B. Description: Mechanically held combination type complying with NEMA ICS 2 and UL 508.
 - 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 - 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 - 3. Enclosure: Comply with NEMA 250 rated for area where installed.
 - 4. Provide with control and pilot devices as indicated within Contract documents, matching the NEMA type specified for the enclosure.

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve not less than 95 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions. Provide back boxes, mounting brackets, guards, trim plates or other required finishes to provide a complete and functional unit.
- B. The locations and quantities of sensors indicated within Contract drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the intended area while meeting 95 percent coverage. It is this contractor's responsibility to arrange a pre-purchase/installation meeting with the manufacturer's factory authorized representative, at the owner's facility, to verify placement of sensors and installation criteria.

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 Division 26 Section "Wire & Cables." Minimum conduit size shall be 3/4 inch.
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Cable type, pair quantity or sizing of conductors according to lighting control 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.
- E. It is this contractor's responsibility to insure exposed cables are properly bundled, supported, protected and rated (plenum) for area of installation.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaries 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. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 - 2. Operational Test: Verify operation of each lighting control device, and adjust time delays.
- B. Lighting control devices which fail tests and inspections are considered defective work and shall be replaced at no cost to the project.

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training." Provide no less than (3) three complete set of operation and maintenance manuals at time of training.

END OF SECTION 260923

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SECTION 262200 - LOW-VOLTAGE TRANSFORMER

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 SCOPE

- A. Dry type energy efficient transformers shall be provided in the distribution system. Transformers shall have kVA and voltage ratings as indicated on the Contract Documents. Transformers 15kVA through 750kVA shall meet HIGH efficiency requirements of D.O.E. 2016 and NEMA Premium Transformers.

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code (Latest Edition)
- B. NEMA ST20-2016 - Dry-Type Transformers for General Applications
- C. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment
- D. DOE Test Method for Measuring the Energy Consumption of Distribution Transformers under Appendix A to Subpart K of 10 CFR part 431.
- E. US Department of Energy, 2016. Energy Conservation Program: Energy Conservation Standards for Distribution Transformers;.
- F. DOE Test Method for Measuring the Energy Consumption of Distribution Transformers under Appendix A to Subpart K of 10 CFR part 431.
- G. IEEE C57.110-1998 – IEEE Recommended Practice for establishing transformer capability when feeding nonsinusoidal load currents.
- H. ISO 14001:2004 – International Standards Organization - Environmental Management System UL 1561 - Dry-Type General Purpose and Power Transformers.
- I. ISO 17025 – International Standards Organization - General requirements for the competence of testing and calibration laboratories.
- J. UL 1561 - Dry-Type General Purpose and Power Transformers.

1.4 SUBMITTALS FOR REVIEW

- A. Product Data: Provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, transformer inrush ratings, tap configurations, insulation system type, and rated temperature rise.

1.5 SUBMITTALS FOR INFORMATION

- A. Test Reports: Indicate loss data, efficiency at 25, 50, 75, and 100% rated load, and sound level.
- B. Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this section shall have a minimum of ten (10) years of experience.
- B. Manufactured in a certified ISO 9001 and 14001 facility.

1.7 REGULATORY REQUIREMENTS

- A. Installation to conform to requirements of NFPA 70 and all local codes and standards.
- B. Products: Listed and classified by Underwriters Laboratories, Inc. or Authority Having Jurisdiction, as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle in accordance with manufacturer’s written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components enclosure, and finish.

PART 2 - PRODUCTS

2.1 BASIC REQUIREMENTS

- A. Sound levels must be 3db below NEMA ST-20-2014 standard levels according to kVA size.
 - 1. Provide audible sound level test report for each transformer reference IEEE C57.1291, NEMA –ST-20-2014.
- B. All insulating materials are to exceed NEMA ST20-2014 standards and be rated for 220 deg.C UL recognized insulation system.
- C. Transformers shall be configured with maximum winding temperature rise of 115degC.
- D. Transformer shall have the following minimum full capacity taps: two (2) 2-1/2% taps above and four (4) 2-1/2% taps below normal rated primary voltage.
- E. Neutral: Neutrals sized to accept 200% rated neutral conductors where 200% feeders are specified on the one-line diagram.
- F. Minimum efficiency shall comply with the following when tested per U.S. DOE 10 C.F.R Part 431 and NEMA TP-2 procedures:

Three Phase Efficiencies and Losses		
KVA Size		Efficiency
15		97.89
30		98.23
45		98.40
75		98.60
112.5		98.74
150		98.83
225		98.94
300		99.02
500		99.14

- G. Enclosure:
 - 1. The transformer shall be protected by a ventilated heavy gauge metal enclosure with ventilating openings. The enclosure shall be degreased, cleaned, primed and finished with baked enamel coating.
 - 2. The transformer core and coil shall be mounted on vibration isolator pads.
- H. Basic Impulse Level shall be 10 kV.
- I. Enclosure: Type 2: Indoor Ventilated Drip Proof; Vermin Resistant. Provide lifting eyes and brackets. Provide NEMA 3R for installations subject to overhead moisture or installed in suitable environment.
- J. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.
- K. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
- L. Transformer shall be suitable for floor mounting unless noted otherwise. Where floor mounted a 4" height fiber reinforced concrete pad extending minimum of 3" inches beyond transformer dimensions and extending beyond meeting manufacturers required ventilation clearances. Whichever dimension is greater.
- M. Isolate core and coil from enclosure using vibration-absorbing mounts.
- N. Transformer coils shall be copper windings of the continuous wound construction type and shall be impregnated with non-hygroscopic, thermosetting varnish.
- O. Harmonic Mitigating: (Where called for with Project Documents)
 - 1. Shall supply phase shift of -15°, 0°, 30° or otherwise noted on contract documents. Minimum K-7 rating.
 - 2. Have an impedance range of 3%-5% with a minimum reactance of 2% to aid in reduction of neutral currents.
 - 3. Dual Electrostatic shielding to be provided. The attenuation of line noise and transients shall equal or exceed the following limits:
 - a. Common Mode: 1.5kHz to 10kHz - 90Db

2.2 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one (1) of the manufacturers specified per models listed or as recommended by manufacturer representative per given application:
 - 1. Siemens
 - 2. Eaton Electric
 - 3. Square D, Schneider Electric

2.3 PROJECT REQUIREMENTS

- A. Primary Voltage: 480 volts unless noted otherwise.
- B. Secondary Voltage: 208/120 volts 4 wire unless noted otherwise.
- C. Phasing: 3-phase and/or single phase unless noted otherwise.
- D. Provide transformer equipment pad for each floor mounted unit as specified within contract documents.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Transformers shall be securely mounted level and plumb, from the building structure or walls with mass at locations shown on Contract documents. Use a neoprene compressive material at points of mounting to cut vibration noises. Sizing of vibration isolators in accordance with actual weight of installed unit. In general, transformers shall be located, set, mounted and connected in such a manner to keep noise levels within the surrounding ambient noise levels.
- B. Provide structural steel angle knee bracing platform to mount transformers on walls or provide angles welded to building structural steel members with rods dropping to angle or channel steel platform necessary to support transformers hung above ceiling. Furnish prime coats of paint on steel. Transformer steel supports shall be designed to adequately carry the load imposed and in no case shall supports be anchored to building steel where imposed loads shall endanger building structural system. Verify structural integrity of area where transformers are to be located. Locate transformers in area to assure adequate air circulation around unit. Coordinate hung transformer weight with General Contractor for approval.
- C. Unit shall be mounted on free standing rubber vibration isolators sized in accordance with actual weight of unit installed.
- D. Use flexible conduit, 24" minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- E. A minimum of 3" space shall be allowed around all ventilation openings or in accordance with manufacturer's recommendations.
- F. Provide grounding bonding and required lugs.
- G. Accessories: All related items required for connection and final installation shall be provided by this contractor including lugs, wire, crimps, lifting apparatus, tape, shields etc.
- H. Mounting location must remain accessible for inspections, replacement and general service.

3.2 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.2.

3.3 ADJUSTING

- A. Measure primary and secondary voltages and make appropriate tap adjustments.

END OF SECTION 262200

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SECTION 262416 – SWITCHBOARDS AND PANELBOARDS

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. Service - Switchboards.
 - 2. Distribution panelboards.
 - 3. Lighting and appliance branch-circuit panelboards.
 - 4. Surge protective devices on panelboards.
- B. Provide electric services with capacity and voltage requirements per contract documents.
- C. Interrupting Capacities: Panel boards to have interrupting capacity capable of handling fault current which is available at the point in the circuit where the panel is installed.
- D. Interrupting ratings are listed within Contract documents. These capacities are based on feeder sizes and panel locations shown within Contract documents. If changes are made, these ratings must be adjusted by the Electrical Contractor.
- E. Source Limitations: Obtain switchboards, panelboards, overcurrent protective devices, components and accessories through one source from a single manufacturer.

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, surge protection device, accessories, and components 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. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Panelboard Schedules: For installation in panelboards.
- D. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," 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.
 - 3. Selective coordination and series rating charts.

1.5 QUALITY ASSURANCE

- A. If an independent testing agency is required, see Division 01 Section "Quality Requirements" for general testing and inspecting agency qualification requirements. If additional control is needed, use one of first two paragraphs below to specify 29 CFR 1910.7 or other more specific criteria (e.g., NETA). 29 CFR 1910.7 defines a nationally recognized testing laboratory as it applies to testing and inspecting for safety, and lists, labels, or accepts equipment and materials that meet certain OSHA criteria.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
- C. Product Options: Project documents indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- D. 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.
- E. Comply with NEMA PB 1.
- F. Comply with NFPA 70.

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.
 - 2. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.
- C. Interruption of Existing Electric Service (Where Applicable): 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 Owner's representative no fewer than 2 days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without written permission by all affected parties.

1.7 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other potential construction interferences such as wall penetrations, supports, including electrical and other types of wall mounted equipment, raceways, piping, and other miscellaneous encumbrances. Electrical Contractor shall maintain NEC workspace clearance requirements.
- B. Coordinate size and location of Electric Contractor provided concrete bases with Utility Provider and various equipment manufacturers. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Electrical Contractor shall coordinate with local utilities and general contractor in preparation of and installation of all underground electric including manholes, handholes and raceways associated with: electric services, telecommunications, fire alarm monitoring points, site lighting and feeders or branch circuits.

1.8 EXTRA MATERIALS

- A. Provide panelboard nameplate per “Electrical Identification” specification 26-05-53.
- B. 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: (6) six spares for each type of panelboard lock.
- C. Permanently provide Stainless Steel plaque containing directory of each service complying with NEC Article 230.2(E). Coordinate plaque verbiage with Project Engineer.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. 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:
 - 1. Switchgear, Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
 - a. Square D (base of design)
 - b. Cutler-Hammer
 - c. Siemens

2.2 SHORT-CIRCUIT RATING

- A. Equipment shall be fully rated to interrupt symmetrical short-circuit current available at terminals.

2.3 GROUND FAULT PROTECTION

- A. The ground fault and overload trip mechanisms shall be of the static type with adjustable, long-time, short-time, and instantaneous both in time and current setting. Ground fault protective circuitry shall be provided in accordance with NEC requirements. Adjustment shall be provided by this contractor.
- B. Provide ground fault protection for service per Contract Documents.

2.4 SERVICES

- A. The utility electric services and utility metering to the facility are existing to remain.

2.5 CONDUIT

- A. Conduit joints shall be sealed with waterproof joint compound. Schedule 40 PVC conduit shall transition to rigid galvanized steel conduit prior to exiting final grade. All conduit bends shall be factory made large radius elbows. Conduits shall be cleaned and free from internal debris prior to assembly. Full bore conduit opening shall be continuous in length and maintained at all times. All foreign matter must be removed from raceways. Provide a pull cord in each conduit.

2.6 SWITCHBOARDS

- A. Not used in this project.

2.7 DISTRIBUTION PANELBOARDS

- A. Distribution panelboards shall be of construction by Square D Type ILINE or an approved manufacturer, 3 phase, 4 wire, voltage as specified within Contract documents.
- B. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.
- C. Doors: Secured with tumbler lock; keyed alike.
- D. Main Overcurrent Protective Devices: 100% rated circuit breaker or as called for within contract documents.
- E. 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: plug-in circuit breakers as furnished by panelboard manufacturer.

2.8 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Lighting and appliance panelboards shall be 3 phase, 4 wire, unless called out otherwise in the Contract documents. Provide voltage and branch circuit quantity as specified within Contract Documents.
- B. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- C. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- D. Available Manufacturers:
 - 1. Square D Type "NF" or "NQ" (Basis of Design)
 - 2. Cutler-Hammer
 - 3. Siemens

2.9 PANELBOARD ACCESSORIES

- A. Accessories: Provide all required accessories required for a complete assembly and as noted but not limited to the following: lug kits, ground and neutral bars, filler plates, breakers, shunt trip devices, breaker handle attachments, circuit ID strips, completed directory card etc.

2.10 SURGE SUPPRESSION

- 1) Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. Siemens Energy & Automation, Inc.
 3. Square D; a brand of Schneider Electric.
- 2) Surge Protection Device: IEEE C62.41-compliant, externally mounted, bolt-on, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:
1. Fuses rated at 200-kA interrupting capacity.
 2. Integral disconnect switch.
 3. Redundant suppression circuits.
 4. Redundant replaceable modules.
 5. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 6. LED indicator lights for power and protection status.
 7. Audible alarm, with silencing switch, to indicate when protection has failed.
 8. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 9. Four digit, transient-event counter set to totalize transient surges.
 - a. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase.
 - b. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.
 - 1) Line to Neutral: 70,000 A.
 - 2) Line to Ground: 70,000 A.
 - 3) Neutral to Ground: 50,000 A.
 10. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
 11. Protection modes and UL 1449 SVR for grounded wye circuits with 208Y/120-V, three-phase, four-wire circuits shall be as follows:
 - a. Line to Neutral: 400 V for 208Y/120.
 - b. Line to Ground: 400 V for 208Y/120.
 - c. Neutral to Ground: 400 V for 208Y/120.
 12. Protection modes and UL 1449 SVR for 240/120-V, single-phase, three-wire circuits shall be as follows:
 - a. Line to Neutral: 400 V.
 - b. Line to Ground: 400 V.
 - c. Neutral to Ground: 400 V.
 13. Protection modes and UL 1449 SVR for 240/120-V, three-phase, four-wire circuits with high leg shall be as follows:
 - a. Line to Neutral: 400 V, 800 V from high leg.

- b. Line to Ground: 400 V.
 - c. Neutral to Ground: 400 V.
14. Protection modes and UL 1449 SVR for 240-, 480-, or 600-V, three-phase, three-wire, delta circuits shall be as follows:
- a. Line to Line: 1000 V for 240 V.
 - b. Line to Ground: 800 V for 240 V.

2.11 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: UL 489, with interrupting capacity to meet available fault currents.
- 1. Provide overload protection for each devices or circuits deriving from panels according to plans or schedules. Where specific circuit has not been assigned to a device or equipment, a properly sized circuit for load served shall be provide at no additional cost to the project.
 - 2. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 3. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 4. Electronic trip-unit circuit breakers shall contain:
 - a. UL listed as field replaceable
 - b. Upgradable without special adjustments
 - c. To be true RMS current sensing
 - d. Field-replaceable rating plug
 - e. Advance relay protection (voltage under/over, phase loss, current imbalance, etc.)
 - f. Field-adjustable settings:
 - 1) Instantaneous trip
 - 2) Long- and short-time pickup levels.
 - 3) Long- and short-time time adjustments.
 - 4) Neutral protection
 - 5) Ground-fault pickup level, time delay, and I2t response.
 - 5. Switchgear main breaker trip unit shall be Square D Micrologic 6.0P or approved equal.
 - 6. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 - 7. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - 8. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - 9. Shunt Trip: Panels in areas where shown on plans shall be equipped with breakers featuring shunt trip coils operating at 120vAC. Coil shall be energized from separate circuit, set to trip at 75 percent of rated voltage unless specified elsewhere or subject to code compliance.

10. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 11. Auxiliary Contacts: One SPDT switch with "a" contacts mimic circuit-breaker contacts.
 12. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function and compliance with NEC 2014 240.87 for all portions for the system with 1200 amp or larger overcurrent devices.
 13. Multipole units enclosed in a single housing or factory-assembled to operate as a single unit.
- B. Branch Breakers
1. Branch circuit portions of each panel board shall comprise the required and indicated number of interchangeable bolt on non combustible thermal magnetic circuit breaker sections; single or multiple pole, rated not less than 20 amperes, 125 volts and higher as noted. Breakers are required to provide I.C. sym. amp as shown on the panel schedule(s).
 2. Circuit breakers shall be readily removable from the front of panel board without disturbing adjacent units. They shall have quick make and quick break toggle mechanisms, non fusible contacts, with inverse time, short circuit characteristics. Breakers shall trip free on overload. They shall indicate clearly whether they are in the open, tripped or closed position. Multipolar units shall have thermal element in each pole and shall have a single handle. Closely grouped circuit breakers and thermal tripping devices mounted in a common cabinet shall be de rated when necessary in accordance with NEMA standard recommended practices for high ambient temperatures.
 3. Circuit breakers protecting circuits supplying receptacles, signaling devices, clocks, special equipment and other similar circuits not requiring switch control shall be equipped with an approved breaker locking device as called for within Contract documents.
 4. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 5. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity. Provide 30-mA trip sensitivity for electric heating equipment conforming to the NEC.
 6. Breakers in panelboards used for switching of circuits shall be rated for switching duty.
 7. Breakers loads which include high intensity discharge (HID) lighting systems, such as mercury vapor, metal halide or high-pressure sodium shall be HID rated.
 8. Lighting applications or other applications where high inrush current exceeds standard tripping conditions, high-magnetic circuit breakers shall be used. Consult branch breaker manufacturer for applications requiring such.
 9. Neutral sharing for multiphase panelboards is not an approved wiring method. All branch circuits shall be wired with a dedicated neutral sized in accordance with the NEC.

2.12 REQUIRED ACCESSORY COMPONENTS AND FEATURES

- 1) Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Customer Metering (Main and Branches)
1. Provide a separate customer metering compartment with front hinged door containing a solid state monitoring system.
 2. The customer metering device shall have the following features:
 - a. All startup parameters shall be stored in nonvolatile memory and retained in the event of a control power interruption.

- b. The meter shall provide the following, true RMS metered quantities:
 - 1) Current, per phase and neutral.
 - 2) Current demand – maximum per phase and neutral.
 - c. Voltage, per phase (L-L, L-N).
 - d. Power, per phase, 3 phase total (kW, kVA, kVAR).
 - e. Power factor, 3 phase total.
 - f. Power demand, (kWd) present and peak.
 - g. Power demand, (kVARd, kVAd) present and peak.
 - h. Real energy (kWh).
 - i. Energy, IN and OUT (kWh, kVARh, kVAh).
 - j. Minimum/maximum readings, currents, voltages, frequency, power factor, and total harmonic distortion.
10. Power demand calculation capabilities.
11. Minimum and maximum value collection with the following recorded attributes:
- a. Date/time of minimum/maximum values.
 - b. Minimum/maximum value.
 - c. Phase of recorded minimum/maximum (for multi-phase quantities).
 - d. All minimum/maximum values shall be available via communications and display.
12. Accuracy of the meter shall comply with ANSI C12.20 Class 0.5 and IEC 60687 Class 0.5 including:
- a. Accurate to 0.25% of reading plus 0.025% of full scale for power and energy.
 - b. Voltage and current shall be accurate to 0.075% of reading plus 0.025% of full scale.
 - c. Power factor metering shall be accurate to ± 0.002 from 0.5 leading and to 0.5 lagging.
 - d. Frequency metering shall be accurate ± 0.01 Hz at 45-67 Hz.
13. Meter shall provide steady state waveform captures of voltage and current channels which shall be stored in non-volatile memory.
14. Meter shall be supplied with one digital input and one digital solid state output.
15. Meter shall have logging capability for alarms, waveform, and three separate custom data logs.
16. Meter shall have capability for user definable alarm conditions.
17. Meter shall have output relay control.
18. Meter shall be field upgradeable to enhance functionality. Upgrades shall not require disassembly or changing of integrated circuit chips and it shall not be necessary to de-energize the circuit or equipment to perform the upgrade.
19. Communicate externally via Ethernet TCP/IP and Modbus (DDC) protocols. Coordinate communication package with DDC system installer.

20. Meter shall be equipped with a back lit LCD display and shall be anti-glare and scratch resistant. The display shall have the following capabilities:
 - a. Provide viewing of four values on the screen simultaneously.
 - b. Provide viewing of a summary screen.
 - c. Provide local access for metered quantities.
 - d. Provide for reset of electrical parameters.
 - e. Provide for setup for system requirements.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. **Install panelboards and accessories** according to NEMA PB 1.1. Mounting shall be plumb and rigid without distortion of box.
- B. Surface mounted electrical equipment shall be installed on 3/4" thick, fire retardant mounting board. Mounting board shall bear UL classified mark indicating ASTM E 84 test compliancy. Backboard material shall have a final applied finish according to manufacturer specifications prior to mounting of electrical equipment. Finishing material may include but not limited to fire retardant coatings. Backboard material shall minimally extend 6" in all directions beyond grouping of electrical equipment. The Electrical Contractor may use discretionary expertise to provide fire retardant backboard for individual equipment such as standalone disconnect switches, starters and the like. Where said devices are grouped (starters, disconnects, contactors etc.) installation shall include fire retardant backboard. Fire retardant mounting board installed on perimeter outside walls to be shimmed 1/2" from wall with washers to permit back ventilation.
 1. Approved manufacturer: Hoover Treated Wood Products Inc. - Pyro-Guard
 2. Approved equal.
- C. Mount top of panelboard cabinets 72 inches above finished floor, unless otherwise indicated.
- D. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- E. Install overcurrent protective devices and controllers.
 1. Set field-adjustable switches and circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub four 1-inch empty conduits from lighting/receptacle panelboards into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- H. 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 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads. 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 for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power 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. Submit all branch circuit changes to the engineer.
 - 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.

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 262416

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SECTION 262726 - WIRING DEVICES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions, General Requirements, Division 1 Specifications, apply to this Section.

1.2 DESCRIPTION

- A. This section covers power-related devices such as receptacles, switches, and plug strips.
- B. Devices listed in this section may or may not be used on this project. Specifications for devices not included in the Contract Documents are included in case they are needed during construction phase.

1.3 LOCATION OF DEVICES

- A. The approximate schematic location of devices is given within Contract documents. The exact location shall be determined at the building as the work progresses. Refer to Architectural plans for any special details, elevations, and reflective ceiling plan. Verify door swings at job site. In no case shall switches be located behind door swings. Any switch so located shall be changed. Field verify equipment location and adjust locations to avoid inaccessibility. Relocate inaccessible outlets.

- B. This contractor shall be responsible for installations of wiring devices meeting ADA requirements where applicable.

- C. Unless otherwise indicated or otherwise decided at the site or required to meet ADA requirements, outlet boxes in walls shall be located with centerline at elevation above the finished floor as noted below:

- D. Fire Alarm Telephone..... 4 feet 9 inches (unless directed by AHJ)
- Fire Alarm Notification 6 feet 8 inches or 6 inches below ceiling in low ceiling areas
- Fire Alarm Pull Stations 3 feet 6 inches (to activation handle)
- Fire Alarm Speaker..... Ceiling mounted or 8 feet or 6 inches below ceiling in low-ceiling (wall mounted) areas
- Fire Alarm Annunciator..... 5 feet 2 inches (unless directed by AHJ)
- Fire Alarm Control Panel..... 6 feet (to top of panel)
- Wall Switch Outlets..... 4 feet 0 inches
- Convenience Outlets (general) 1 foot 6 inches
- Convenience Outlets (mechanical areas)..... 4 foot 0 inches
- Counter Outlets..... 8 inches above countertop
- Desk Telephone Outlets..... 1 foot 6 inches
- Wall Telephone Outlets 5 feet 0 inches

Telephone Outlets above Counter	8 inches above countertop
Thermostat.....	4 feet 4 inches
Public Telephone Outlets.....	Coordinate with telephone company
Plug In Strip.....	To be determined at the site
Exterior and Interior Wall Brackets.....	To be determined at the site

- 1. The Architect and Owner's representative reserve the right to change the location of any outlet, before installation.**

1.4 DESCRIPTION

A. Wiring Device Requirements

1. Use the products of a single manufacturer for each type of wiring device.
2. Receptacles for general equipment or Owner's-Furnished Equipment: match cord-plug configurations.
3. Use the products of a single manufacturer of all wiring and device plates. Obtain prior approval for any variations from this requirement, except that plate variations are allowed for the following devices:
 - a. Where the selected plate manufacturer does not manufacture a suitable finish plate.
 - b. For heavy-duty receptacles rated at more than 30 amperes.
 - c. Where the raceway system enclosure employs a non-standard finish plate.
 - d. Where non-standard plates are specified or indicated.

B. Cover Plates

1. Unless otherwise prohibited by wiring device, cover plates shall be stainless steel as define within section 2.7 of this document.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Representative general purpose wiring devices and device plates as listed herein are intended to indicate type, function, and quality of the products. Provide the products as specified.
 1. Industrial/Institutional construction type:
 - a. Receptacles, toggle and snap switches: Hubbell, Pass & Seymour, Leviton, Cooper Wiring Devices
 - b. Lighting Control; Dimmers & Occupancy Sensors: Hubbell, Leviton, Wattstopper, Lithonia, Cooper Wiring Devices
 - c. Time Switches: Intermatic Inc., Tork, MH Rhodes
 - d. Exterior/Cast: Crouse-Hinds, Appleton, Hubbell, Cooper Wiring Devices
 2. Hospital Grade:
 - a. Tamper-resistant duplex receptacles. Manufacturer as named above.

2.2 STANDARDS

- A. Straight-Blade-Type Receptacles: Comply with NEMA WD 1, NEMA WD 6, DSCC W-C-596G and UL 498.
- B. GFCI Receptacles: Straight blade, non-feed-through type, with integral NEMA WD 6, complying with UL 498 and UL 943-2003. Design units for installation in a 2-3/4" deep outlet box without an adapter.
- C. Pendant Cord/Connector devices shall have matching, locking-type plug and receptacle body connector, NEMA WD 6, Configurations L5-20P and L5-20R, Heavy-Duty grade.
 - 1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
 - 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.
- D. Single- and Double-Pole Switches: Comply with DSCC W-C896F and UL 20.
- E. Wiring device color unless specifically noted within contract documents are to be determined for finished spaces by the Interior Designer except the following:
 - 1. Black within equipment rooms (electrical, mechanical, technology closets)
 - 2. Red fed from emergency or standby power circuits
 - 3. Yellow for exterior weather resistant duplex receptacles

2.3 SWITCHES

- A. General:
 - 1. Device (general use) color: White within finished areas, White for lighting controls within finished areas, Ivory mounted in surface mounted raceways or black within unfinished areas. All color choices shall be confirmed with Architect.
 - 2. Switches mounted vertically shall have the "ON" position at the top and horizontal-mounted switches shall have the "ON" position at the left. Unless otherwise indicated switches shall be mounted in the vertical position.
 - 3. Tumbler switches shall be the AC heavy-duty, specification grade, 120/277 volts, flush toggle type switch rated at 20 amperes, Underwriters' approved and meeting NEMA Standard WD-1 1965 and Federal Specifications W-S-896d (Type III). The operating mechanism shall be totally enclosed in a high-heat, non-inflammable, non-hygroscopic molded compound case with terminal screws located on the side of the switch. Operating handles shall be made of high heat phenolic compound. Switches shall have wide plaster ears.
 - 4. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switch and audible frequency and EMI/RFI filters. Architectural grade, preset slide control, plate kit, AC dimmer with minimal wattage (after derating) and specified voltage for intended load. Contractor provided dimmer shall be compatible with fluorescent ballast manufacturer.
 - a. 120v Hubbell AS-103, AS-153, AS-203 (White) P&S, Leviton
 - b. 277v Pass & Seymour 93271, 93472, 93673, 93874 (White) – Magnetic, Hubbell, P&S
 - c. 277v Leviton MNX20-7L, MNX30-7L (White) – Electronic, Hubbell, P&S.
- B. Occupancy/Vacancy Sensors:
 - 1. See specification 260923 "Lighting and Control Devices".

C. Manufacturers:

1. Single pole toggle switch, 20 ampere, 120-277 volt, institutional grade, Hubbell Catalog No. HBL1221, Pass & Seymour, Cooper Wiring Devices or Leviton equal.
2. Keyed single pole toggle switch, 20 ampere, 120-277 volt, industrial-institutional grade, Hubbell Catalog No. HBL1557L, Pass & Seymour, Cooper Wiring Devices or Leviton equal.
3. Three-way toggle switch, 20 ampere, 120-277 volt, institutional grade, Hubbell Catalog No. HBL1223, Pass & Seymour, Cooper Wiring Devices or Leviton equal.
4. Four-way toggle switch, 20 ampere, 120-277 volt, institutional grade, Hubbell Catalog No. HBL1224, Pass & Seymour, Cooper Wiring Devices or Leviton equal.
5. Double pole toggle switch, 20 ampere, 120-277 volt, institutional grade, Hubbell Catalog No. HBL1222, Pass & Seymour, Cooper Wiring Devices or Leviton equal.
6. Single pole key lock switch, 20 ampere, 120-277 volt, institutional grade, Hubbell Catalog No. HBL1221-L, Pass & Seymour, Cooper Wiring Devices or Leviton equal.
7. Single pole toggle switch with pilot light on with load off, 20 ampere, 120 volt, institutional grade, Hubbell Catalog No. HBL1221-PL, Pass & Seymour, Cooper Wiring Devices or Leviton equal.
8. Three-way toggle switch with pilot light on with load off, 20 ampere, 120-277 volt, institutional grade, Hubbell Catalog No. HBL1223-IL, Pass & Seymour, Cooper Wiring Devices or Leviton equal.
9. Momentary contact switch, 3-position, 2-circuit, center off, 20 ampere, 120-277 volts, institutional grade, Hubbell Catalog No. HBL1557.
10. Maintained contact switch, 3-position, 2-circuit, center off, 20 ampere, 120-277 volts, institutional grade, Hubbell Catalog No. HBL1385.
11. Fan switches — coordinate with fan supplier (switch is normally provided by fan supplier; if not, provide single-pole switch listed above or provide manual motor starter per specification 262913 where motor overload protection is not provided).

D. Miscellaneous Switch Appurtenances:

1. Weatherproof cover - Hubbell 1795
2. Locking cover - Hubbell 96061
3. Pass & Seymour, Leviton equal.

2.4 CONVENIENCE RECEPTACLES

- A. Receptacles for convenience outlets shall be duplex self-aligning grounding type rated for 20 amperes at 125 volts. Contacts shall be made of heavy spring copper or bronze so designed as to securely grip both sides of each receptacle blade and shall be enclosed in high heat, non-inflammable, non-hygroscopic molded compound case, provided with wide plaster ears. Each terminal shall be provided with two (2) binding screws located on the side of the receptacle. Hubbell Catalog No, IG5362GY, Pass & Seymour, Cooper Wiring Devices or Leviton equal.
- B. Where noted within Contract documents, tamper-resistant convenience outlets shall be rated for 20 amperes at 125 volts with integral shutter or reciprocating contact system meeting minimum requirements as noted above. Nylon face shall visually identify unit as tamper resistant; Hubbell Catalog No, HBL8300SGGYA, Pass & Seymour, Cooper Wiring Devices or Leviton equal.
- C. USB Receptacles (Where noted within Contract documents): Shall be tamper-resistant Decora type rated for 20 amperes at 125 volts with integral shutter or reciprocating contact system containing (2) high powered 5vDC 3.6A USB 2.0 Type A integral charging ports. Leviton T5832, Hubbell, Pass & Seymour or Copper Wiring or equal.

D. Manufacturers:

1. Generator fed receptacle (derived from "E" or "S" type panels), 20 ampere, 125 volt, 2 pole, 3 wire grounding type, NEMA 5-20R, red in color and connected to the normal/emergency/standby system; Hubbell Catalog No. HBL5362R, Pass & Seymour, Cooper Wiring Devices or Leviton equal. The stainless steel cover plate shall have the word "Generator" engraved at the top with red filled lettering.
2. Ground fault interrupter type duplex receptacle, 20 ampere, 125 volt, 2 pole, 3 wire grounding type, NEMA 5-20R; Hubbell Catalog No. GFR5352-__ST, Pass & Seymour, Cooper Wiring Devices or Leviton equal.
3. Safety type duplex receptacle, 20 ampere, 125 volt, 2 pole, 3 wire grounding type, NEMA 5-20R. Pass & Seymour Catalog No. SG-62
4. Duplex receptacles fed from computer panelboards shall be of color white, 20 ampere, 125 volt, 2 pole, 3 wire grounding type, NEMA 5-20R, Hubbell Catalog No. 5362OW (white), Pass & Seymour, Cooper Wiring Devices or Leviton equal.
5. Single receptacle, 20 ampere, 125 volt, 2 pole, 3 wire grounding type, NEMA 5-20R ("EWC" denotes electric water cooler-coordinate mounting height with the equipment supplier); Hubbell Catalog No. 5361-BK, Pass & Seymour, Cooper Wiring Devices or Leviton equal.
6. Exterior duplex receptacles shall be yellow in color weather resistant type. Leviton WBR20-Y, Pass & Seymour or Hubbell equal.

E. Appurtenances:

1. Weatherproof covers - use Hubbell WP26 or WPSF26, Pass & Seymour Catalog No. WPH8 or Bryant Catalog No. 4510D for GFI-WP locations; or Hubbell 5205WO or 5206WO, Pass & Seymour Catalog No. WPH26 for non-GFI-WP locations. Leviton equal.

2.5 PROTECTED RECEPTACLES

- A. Receptacles shall be ground fault and/or arc-fault protected in accordance to Articles 210.8 and 210.12 of 2011 National Electric Code.

2.6 SPECIAL PURPOSE RECEPTACLES

- A. Special purpose receptacle, size and type as called for within Contract documents. (Each receptacle shall be provided with one matching plug for installation on the associated piece of equipment.)
- B. 30 ampere, 125 volt, 1 phase, 2 pole, 3 wire grounding type, single receptacle, with black face, NEMA 5-30R. Hubbell Catalog No. 9308. (Plug-Catalog No. 9309), Pass & Seymour, Cooper Wiring Devices or Leviton equal.
- C. 20 ampere, 250 volt, 1 phase, 2 pole, 3 wire grounding type, single receptacle, with brown face, NEMA 6-20R. Hubbell Catalog No. 5461. (Plug-Catalog No., 5466-CA), Pass & Seymour, Cooper Wiring Devices or Leviton equal.
- D. 30 ampere, 250 volt, 1 phase, 2 pole, 3 wire grounding type, single receptacle, with black face, NEMA 6-30R. Hubbell Catalog No. 9330. (Plug-Catalog No. 9331), Pass & Seymour, Cooper Wiring Devices or Leviton equal.
- E. 50 ampere, 250 volt, 1 phase, 2 pole, 3 wire ground type, single receptacle, with black face, NEMA 6-50R. Hubbell Catalog No. 9650. (Plug-Catalog No. 9650-ANP), Pass & Seymour, Cooper Wiring Devices or Leviton equal.
- F. 50 ampere, 125/250 volt, 1 phase, 3 pole, 4 wire grounding type, single receptacle with black face NEMA 14-50R. Hubbell Catalog no. 9450-FR. (Plug Catalog No. 9452- ANP), Pass & Seymour, Cooper Wiring Devices or Leviton equal.

- G. 20 ampere, 250 volt, 1 phase, 2 pole, 3 wire grounding type, single twist, single twist-lock receptacle, with black face, NEMA L6-20R. Hubbell Catalog No. 2320. (Plug-Catalog No. 2321-CA), Pass & Seymour, Cooper Wiring Devices or Leviton equal.
- H. 30 ampere, 250 volt, 1 phase, 2 pole, 3 wire grounding type, single twist-lock receptacle, with black face, NEMA L6-30R. Hubbell Catalog No. 2620. (Plug-Catalog No. 2621-CA), Pass & Seymour, Cooper Wiring Devices or Leviton equal.
- I. 50 ampere, 125/250 volt, 1 phase, 3 pole, 4 wire grounding type, single twist-lock receptacle, with black face, NEMA L6-50R. Hubbell Catalog No. CS6369. Hubbell Catalog No. 6365, Pass & Seymour, Cooper Wiring Devices or Leviton equal.
- J. 30 ampere, 125/250 volt, 1 phase, 3 pole, 4 wire grounding type, single twist-lock receptacle, with black face, NEMA L14-30R. Hubbell Catalog No. 2710. (Plug-Catalog No. 2711-CA), Pass & Seymour, Cooper Wiring Devices or Leviton equal.
- K. 50 ampere, 125/250 volt, 1 phase, 3 pole, 4 wire grounding type, single receptacle with black face NEMA 14-50R. Hubbell Catalog No. 9450-FR. (Plug Catalog No. 9452-ANP), Pass & Seymour, Cooper Wiring Devices or Leviton equal.
- L. 20 ampere, 250 volt, 3 phase, 3 pole, 4 wire grounding type, single twist-lock receptacle, with black face, NEMA L15-20R. Hubbell Catalog No. 2420. (Plug-Catalog No. 2421), Pass & Seymour, Cooper Wiring Devices or Leviton equal.

2.7 COVER PLATES

- A. Unless otherwise specified, toggle switch, wall mounted occupancy/vacancy sensors, receptacles, special purpose outlets, wall mount telephone and other wiring device plates shall be Bureau of Standards No. 302-18.8 brushed or satin stainless steel with beveled edges so as to lie flat against the wall. Where more than one (1) switch or receptacle occurs at one point, use a single multi-gang plate.
- B. Zinc-coated plates may be used in unfinished spaces.
- C. Plates shall be set true and plumb and shall fit tight against finished wall surfaces and outlet boxes.
 - 1. Manufacturers: Hubbell 97000 Series, Pass & Seymour, Cooper Wiring Devices or Leviton equal.
- D. Identification: Plates shall be marked with panelboard and branch circuit serving wiring device on inside of plate as directed by Specification 260553 "Electrical Identification".

2.8 FLOOR BOXES

- A. Floor boxes are flush floor mounted of type noted at locations shown on plans or otherwise scheduled.
- B. Floor boxes shall be of proper type as called for and sized as required by the NEC and shall be secured firmly in place and set true and flush with the final finished floor surface.
- C. Floor boxes shall be fully fitted with required number of receptacles, modular communication connectors (phone, data, video, audio etc), separators, partitions, plates, sub plates, trim rings, metal covers and other necessary items required for a complete assembly. Other specifications requirements by particular manufacturer.
 - 1. Characteristics: Complete factory assembled unit consisting of floor fittings, cover assembly, application plates and suitable for both on or above grade applications. Assembled unit having a UL listed 514A and 514C for scrub water requirements. Final cover plate shall match final floor finish or as noted on architectural documents. Where required, assembly shall have UL listing for use in fire rated floors. Floor boxes are rated and acceptable for use in environmental air handling spaces per NEC article 300.22(C). Separate raceways and sections for power and communications with minimum power size of 3/4" and 1" for communications.

2. Sub-plate: Provide a complete fully fitted plate meeting minimum requirements as shown within Contract documents. Furnished sub-plate shall include receptacles, data, video, audio or furniture feeds as required.
- D. Manufacturer:
1. Hubbell : S1CFB cast box, S1CFCBRS or S1TFCBRS brass cover, S1SP4X4 or other sub-plate configuration to met project requirements.
 2. Hubbell: B2437 or B4214 cast box, brass screw cover plate for tile or terrazzo floors such as but not limited to: S3625, S2825 or S3425.
 3. Manufacture and model as called for within Contract Documents. Include required plates, sections, faceplates, terminations including specified construction.
 4. Approved equal from Leviton or Pass & Seymour.

2.9 EXTRA MATERIALS

1. Provide (10) additional cord reels matching those cord reels specified on the electrical power plans.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Devices shall be flush mounted unless otherwise noted. Properly align level and plumb devices including plates. Plates shall fit flat against wall and tight against device surface without straining or buckling the plate.
- B. Devices to be recessed mounted flush and level in CMU (Concrete Masonry Unit) walls in all areas except mechanical and electrical rooms. Devices shall be installed in a neat and workmanlike manner. Holes for device boxes shall be saw-cut and uniform. Cuts shall be plumb and level, with minimal space around perimeter of boxes that will require grout. Boxes shall be grouted in place.
- 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.
- D. Code sized (#12 minimum) bonding jumper shall connect grounded outlet box to receptacle grounding terminal on flush-mounted units.
- E. Where receptacles are indicated as split-wired and half of the receptacle is on a wall switch, the top receptacle shall be switched and bottom shall be on normal power.
- F. Switches mounted vertically shall have the "ON" position at the top.
- G. Receptacles shall be mounted in the vertical position with the ground terminal on bottom.
- H. Install wall dimmers achieving minimum wattage of connected load including sufficient capacity after de-rating for ganging according to manufacturer's written instructions. Sufficient clearances shall be maintained where dimmers are ganged. Provided dimmers controlling fluorescent ballasts shall be compatible.
- I. Devices installed in areas for use by physically disabled persons, such devices shall be mounted in accordance to Americans Disabilities Act. Refer to architectural drawings, Architect or on-site representative for ADA designated areas.
- J. Wiring devices shall have power feed wiring labeled within device box with circuit and panelboard source.

3.2 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports when requested.
 - 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 262826

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SECTION 262730 - TAPS, SPLICES & TERMINATIONS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions, General Requirements, Division 1 Specifications, apply to this Section.

1.2 DESCRIPTION

- A. Provide taps, splices and termination devices approved and sized for copper cables at voltage and current rating matching characteristics of terminating conductor.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Conductors splices in No. 10 AWG and smaller wire to be made with Minnesota Mining Manufacturing Co. insulated "Scotch Locks", Ideal Co. "Wing Nut", T. & B "Piggy" connectors, or with mechanically crimped sleeves as manufactured by T & B or Ideal Company, which shall be insulated with pressure sensitive electrical tape equal to Scotch No. "33+" or No. 88. Splicing components shall be rated for copper and aluminum conductors.
- B. Conductors #8 AWG and larger shall be terminated, spliced, and tapped with Thomas & Betts color-keyed compression connector's series 54000 or equal. The manufacturers recommended tools and dies shall be used.
- C. Copper cable lug connections #8 and larger to copper bus bar mains and branches shall use copper solderless connectors having either 2-bolt cast copper clamps or compression connectors, Thomas & Betts Series 54000 with manufacturer's recommended hexagonal dies and hydraulic compression tools.
- D. 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.
- E. Connections to equipment shall be made with pressure type terminals. Stranded wire shall use spade type terminals or terminal approved for use. Connections shall contain one conductor unless otherwise rated for multiple conductors.

2.2 MANUFACTURERS

- A. 3-M, O.Z., Thomas & Betts or approved equal.

2.3 WIRE LABELS

- A. Each cable or wire termination shall be identified as noted on drawings, schedules or where not indicated, label shall note applicable branch circuit, phase and/or connected equipment. Labels shall be pressure sensitive or clip on PVC type. Approved Manufacturers: Brady, 3M or approved equal.

2.4 TERMINAL BLOCKS

- A. Where terminal blocks/strips are indicated or otherwise required, provide a complete assembly of blocks/strips having each terminal equipped with two clamp type pressure lugs or two washer bead binding screws. Use terminal strips with voltage and ampere rating sufficient to carry intended loads. Provide a white marking strip along the center line of each row of terminal for identification. Use strips having plastic barriers between adjacent terminals. Provide indicated terminal quantities or otherwise required. If quantity is not indicated, provide one terminal for each conductor entering enclosure plus 20 percent spare terminals. Type or otherwise mark the

identification strip to identify each connected circuit. Relate identification to wiring diagrams, panel schedules and other terminals in a logical manner, where specific identification requirements are not indicated. Under no circumstances shall more than one wire be terminated under each terminal unless rated otherwise. Use only approved type jumper to mechanically connect terminals to each other.

1. Approved Manufacturer: Allen Bradley, IlSCO, Marathon or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Make taps, splices, and terminations at junction boxes, pull boxes, switches, panel boards, and any other electrical equipment, etc. Wires shall be continuous between outlet to outlet, or from panel board to the first outlet, etc.
- B. Backboxes, device boxes, fittings or junction boxes shall be suitably sized permitting adequate conductor fill capacity per Article 314 of the National Electrical Code.
- C. All taps and splices shall be fully insulated meeting minimum insulating values of wire or conductors used.
- D. After splices are mechanically secure, provide listed electrical tape to insulate splice to equal the original insulation voltage rating of the wires, or utilize Thomas & Betts heat shrinkable insulators Series H.S. If the type of connector installed provides equivalent insulation, taping may be omitted.
- E. EC shall provide and install all feeders and branch circuit wiring to all disconnect switches, equipment, controllers, motors and wiring devices. Terminations shall be in full compliance with project documents and meet the installation requirements of the manufacturer.

END OF SECTION 262730

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SECTION 262813 - FUSES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions, General Requirements and Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION

- A. Provide fuses in accordance with the contract documents in motor starters, switchgear assemblies, panel boards, disconnect switches, control devices, lighting fixtures or other required components or equipment.
- B. Fuses shall be provided and installed in equipment being furnished by the respective contractor.
- C. This Section includes: Cartridge fuses rated 600 V and less for use in equipment or components as specified or noted within contract documents.
- D. Provide a complete set of three (3) spare fuses for each fuse size and type used.
- E. All fuses provided shall be of the indicating type, employing either an indicating window or a mechanical indicator striker pin where available.
- F. Where ambient temperature to which fuses are directly exposed is less than 40 degF or more than 100 degF, apply manufacturer's ambient temperature adjustment factors to fuse ratings.
- G. Fuses shall be current limiting with 200,000 ampere interrupting capacity and UL labeled or as specified by manufacturer.
- H. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Obtain fuses from a single manufacturer.
- B. Fuses shall be of the high interrupting rating, current limiting type and manufactured by the Bussman, Mersen, Cooper Edison or Littelfuse.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment in accordance to the National Electric Code.
- B. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- C. Ensure that fuses are firmly and completely inserted into fuse holders and that mechanical joints are tightened.

END OF SECTION 262813

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SECTION 262816 - ENCLOSED SWITCHES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions, General Requirements and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
 - 1. Fusible switches.
 - 2. Non-fusible switches.
 - 3. Molded-case circuit breakers.
 - 4. Enclosures.

1.3 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.
 - 1. Shop Drawings: Diagram power, signal, and control wiring.
 - 2. Field quality-control test reports.
 - 3. Operation and maintenance data.

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.
 - 1. Comply with NFPA 70.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - 1. Eaton Corporation; Cutler-Hammer Products.
 - 2. Square-D/Group Schneider
 - 3. Cooper/Bussmann – Power Module

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

- A. Fusible Switch, 1200A and Smaller: NEMA 12, heavy duty type , with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- B. Non-fusible Switch, 600A and Smaller: NEMA-12, heavy duty type, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit (where required): Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

D. Elevator (New Installation Only)

1. Provide Elevator Control Switch in a single NEMA 12 enclosure with all necessary relay(s), control transformer and options (as listed below) and as shown within Contract Documents. The Elevator Control Switch shall be constructed, listed and certified for use with elevator control. The Elevator Control Switch shall have an ampere frame rating meeting minimum ampere requirements of selected elevator and shall include a horsepower rated fusible switch with shunt trip capabilities. The ampere rating of the switch shall be based upon elevator manufacturer requirements and utilize Class J Fuses which are provided by the Electrical Contractor. The Elevator Control Switch shall include 100 VA control power transformer with primary and secondary fuses. The primary voltage rating shall match the incoming elevator supply voltage with a 120 volt secondary. It shall also contain an isolation relay (3PDT, 10 amp, 120V). The coil of the isolation relay shall be 120v. A normally open dry contact shall be provided by the Fire Alarm Safety System to energize the isolation relay and activate the shunt trip solenoid (140 VA @ 120vAC). The switch shall include a 120 volt key to test switch and a 1-NO/1-NC mechanically interlocked auxiliary contact rated 5A, 120vAC as standard. The switch shall contain the following options:
 - a. "ON" Green pilot light
 - b. Isolated Full Capacity Neutral Lug
 - c. Fire Alarm Voltage Monitoring Relay (Needed to comply with NFPA 72)
 - d. Main Switch Auxiliary Contacts (1 NO/1 NC)

2.3 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

- A. Molded-Case Circuit Breaker: NEMA-1, with interrupting capacity to meet available fault currents.
- B. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250A and larger.
 1. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 2. Current-Limiting Circuit Breakers: Frame sizes 400A and smaller and let-through ratings less than NEMA FU 1, RK-5.
 3. GFCI Circuit Breakers: Single- and two-pole configurations with 5mA trip sensitivity.
- C. Molded-Case Circuit-Breaker Features and Accessories:
 1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Mechanical style with lug kits suitable for number, size, trip ratings, and conductor material.
 3. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 4. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 5. Shunt Trip: 120V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

2.4 ENCLOSURES

- A. NEMA-1 minimal rating or otherwise required meeting environmental conditions at installed location.
 - 1. Outdoor Locations: NEMA 250, Type 4.
 - 2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.
 - 1. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.
- B. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.
- C. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."

3.2 FIELD QUALITY CONTROL

- A. Prepare for acceptance testing as follows:
 - 1. Inspect mechanical and electrical connections.
 - 2. Verify switch and relay type and labeling verification.
 - 3. Verify rating of installed fuses.
- B. CLEANING
 - 1. On completion of installation, inspect interior and exterior enclosures. 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 262816

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SECTION 262913 – MOTOR STARTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions, General Requirements and Division 1 Specification Sections, apply to this Section.

1.2 SCOPE

- A. Provide motor starters in accordance with the Contract Documents. Motor starters may or may not be furnished under this Division, but shall comply to the requirements indicated in this section. Receive, install and connect motor starters not pre-assembled and pre-wired by equipment manufacturer. Notify Associate if any starters do not conform to these requirements. Motor starters in heating equipment shall be supplied under Division 23 and installed under this Division.
- B. Where motor horsepower is equal-to or greater than five, motor controllers shall be provided with integral phase loss protection. Under phase-loss conditions, the phase detection device shall remove power from all phases of the connected motor.
- C. Related Work Specified Elsewhere: This specification describes the electrical work related to manual motor switches, manual motor starters, magnetic motor starters and combination motor controllers external to Motor Control Centers.

1.3 STANDARDS

- A. Conform to NEMA voltage rating for motors and motor control equipment.
- B. Motor branch circuit protective devices shall meet requirements of NEC 430.
- C. UL 98 - Enclosed and Dead Front Switches
- D. NEMA KS 1 - Enclosed Switches
- E. NEMA 250 - Enclosures for Electrical Equipment

1.4 SUBMITTALS

- A. Shop Drawings: Submit general shop drawings, brochures, catalog cuts, dimension sheets and full data schedule of starters to be furnished.
- B. Wiring Diagrams: Submit full starter wiring diagrams showing project remote operating controls, interlocks, safeties, freeze stats, pressure switches, etc. Separate wiring diagram shall be provided for each type motor or by function.
- C. Operational Data: Submit descriptions of working parts, list of replacement parts and adjustment instructions for components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the manufacturers specified.
 - 1. General Electric
 - 2. Allen Bradley
 - 3. Square D
 - 4. Eaton Electric

2.2 COMBINATION MOTOR STARTERS

- A. Combination starters shall be combined with motor overload, short circuit protection and disconnecting means. Manufactured to NEMA standards with UL listing at 480vAC rated 100,000 amps fault current.
- B. Disconnecting means via flange mount operating handle capable of being locked in the open position. Disconnect switches shall be heavy duty, quick make, quick break and interlocked with operating handle. Combination starter to be fusible, non-fusible, thermal magnetic breaker or supplied with motor circuit protector (MCP). Fuses where provided shall be class RK5 with 1-set furnished as spare. Settings of MCP type breaker shall be based on field installed motor nameplate amperage ratings following manufacturer adjustment procedures.
- C. External manual reset mechanism provided for each combination starter as required to reset the single block three-coil motor overloads. Motor overloads shall be provided and correctly sized based upon nameplate data of field installed motors. Do not size over loads based upon typical rating charts.
- D. Each starter shall have an extra auxiliary NO/NC contact for future control purposes.
- E. Where not otherwise indicated, magnetic starters shall contain flange mounted stop start push button stations. Where remote automatic control is indicated a HAND-OFF-AUTO selector switch shall be mounted in the face or flange of each starter enclosure. The selector switch shall be so wired that when it is in the HAND or AUTO position, all safeties are wired in series with the selector switch; control devices shall be wired in the AUTO position only.
- F. Control voltage shall be maximum voltage of 120vAC. Each starter enclosure shall have a suitable secondary control transformer fused separately on each phase of the primary and secondary, and the secondary grounded. Where indicated within Contract documents, 120v control voltage maybe sourced separately otherwise shall be internally sourced.
- G. Each starter shall have a transformer type green pilot light mounted in the face at the starter enclosure indicating motor operating status: "Running". The pilot light shall be wired so it will be on when the motor is energized.
- H. Magnetic starters shall be furnished for motors, one-half horsepower and greater or any three-phase motor, unless indicated otherwise within Contract documents. Motor controllers shall have integral phase-loss protection and phase failure relays with auxiliary NO/NC contacts.
 - 1. Motor monitoring shall include phase loss, phase reversal, voltage unbalance and under voltage. Features may include adjustable trip and restart delay, restart lock-out function and adjustable voltage unbalance settings.

2. Phase loss module shall be provided by the electrical contractor by being an integral part of motor controller, mounted within motor controller or mounted in a labeled enclosure mounted adjacent to motor controller.
3. Unless otherwise restricted via manufactures installation requirements, wiring of phase loss module shall be on the load (motor leads) side. Line side monitoring is not preferred.
4. Manufacturers: Subject to compliance, provide phase-loss module by one (1) of the manufacturers specified.
 - a. Same approved manufacture as motor controller/combination starter.
 - b. ABB - HLMU Series
 - c. Time Mark Corp. - Model 269R
 - d. Macromatic - PMP (plug-in)
 - e. Allen Bradley, Square D or GE approved equal.
- I. Minimum starter size of NEMA 1 or as otherwise called for within Contract documents. Where installation restriction requires IEC style enclosure and equipment, approval of usage shall be obtained prior ordering. Starter control devices shall consist of Allen Bradley 800T/H components or approved equal by Square D or GE.
- J. Remote control stations or related control components not mounted in cover of motor starter shall be heavy duty units of required devices mounted in an enclosure rated for area for which it's installed. Control stations shall be assembled using Allen Bradley 800T/H components.
- K. Square D Class 8500 or General Electric CR208, Allen Bradley Type 500, 800T/H.

2.3 MANUAL MOTOR SWITCHES

- A. Provide for fractional horsepower motors where no remote control is required. Toggle switches may be used for controlling single phase motors of 1/8 horsepower or less and shall be equipped with integral thermal protection. Said switches shall include neon, LED or other indicating pilot light. Provide Square D, Class 2510, General Electric Type CR101, Allen Bradley Type 609.
- B. Enclosures shall be rated for area where installed or as otherwise called for within Contract documents.

2.4 VARIABLE FREQUENCY CONTROLLER (AFD's)

- A. Variable frequency controllers furnished by others shall be installed including power wiring by the Electrical Contractor. Control wiring shall be provided by the Temperature Controls Contractor. Programming of variable frequency drive by Electrical Contractor under the direction of Temperature Controls Contractor.
- B. The Electrical Contractor shall provide all variable frequency controllers, cabinets, mounting hardware, cooling, heating, grounding, noise suppression and wiring. Programming of variable frequency drive by Electrical Contractor under the direction of Temperature Controls Contractor where required. Refer to Specification 26 29 23 and relating specifications in Division 26.
- C. Installation and wiring of controller shall strictly confirm to the manufacturer installation requirements. No exceptions. Deviations taken by the Electrical Contractor may void drive or other related sub-components warranty resulting in financial responsibility of the Electrical Contractor.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Overload heater charts shall be furnished mounted inside doors of cabinets or separately framed and mounted outside the equipment. Also provide in service manual.
- B. Motors whose inrush current exceeds 40 percent of the building transformer rating shall be equipped with reduced voltage or soft start starter.
- C. Connect hand off auto selector switches so that automatic control only is bypassed in "manual" position. All safety controls are maintained whether in the auto or manual position.
- D. Where indicated, and approved by Code, motor controllers may be omitted when horsepower rated thermostat, float, or pressure switches and similar devices are provided which can control the motor directly. Omit motor controls only where starting and running motor protection is established by other means satisfactory to conform to National Electric Code Requirements. Motor overload protection on all phases is a requirement.
- E. Install motor switches in flush enclosures in finished areas unless otherwise noted.
- F. Examine schedules, control diagrams, and manufacturer's shop drawings before ordering motor controllers. Order controllers to satisfy diagrams and project document requirements. Should conflicting data exist in specifications, drawings, and diagrams, request corrected data prior to placing orders.
- G. Where motor starting equipment is shown or required to be free standing, provide suitable galvanized steel framing to support required equipment.
- H. Provide a raised 4 inch concrete slab to mount freestanding motor equipment.
- I. Separately mounted motor starters furnished under Division 23 shall be installed by this contractor meeting respective manufacturer requirements.

END OF SECTION 262913

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SECTION 263213 – ENGINE GENERATOR

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. Provide all labor, materials to install and place in operation a natural gas power generation system in accordance with the contract documents and manufacturer's drawings and installation instructions. These specifications also describe requirements for the design, fabrication and testing of the power system. The total installation shall conform to manufacturer's recommendations. The generator and enclosure have been prepurchased by the owner for installation and start-up by this contractor.
- B. The existing generator and battery charger shall be removed by this contractor and transported to the Wilson Elementary project site on Little Dry Run Road. In addition the this contractor shall obtain the services of the generator manufacturer to make the following modifications to the existing 125KW Kohler generator:
1. Coordinate the relocation, timing a logistics with the Wilson General Contractor.
 2. The contractor shall remove the generator with care. Prior to removal, in conjunction with the owner the generator operation shall be demonstrated.
- C. Fuel supply and connection to generator set shall be made by installation contractor.
- D. The installation of the power generation system shall include the following:
1. Engine-driven generator set
 2. Control and monitoring system
 3. Cooling system
 4. Generator set accessories
 5. Remote annunciator
 6. Mounting system
 7. Base slab and vibration isolation
 8. Weatherproof housing, sound attenuated
- E. Any and all exceptions to the published specifications shall be subject to the approval of the Engineer.
- F. The power system shall be furnished by a single manufacturer who shall be responsible for the design, coordination, and testing of the complete system. The entire system shall be installed as shown on the plans, Contract documents, drawings, and specifications herein.
- G. The equipment shall be produced by a manufacturer who is ISO 9001 certified for the design, development, production, installation, and servicing of complete product line.
- H. It is the intent of this specification to secure electrical power systems that have been tested during design verification, production and at the final job site. All furnished equipment shall be of the latest commercial design

and will be complete with all of the necessary accessories for complete installation as shown on the plans, drawings, and specifications herein. The equipment supplied and installed shall meet the requirements of the National Electrical Code, along with all applicable local codes and regulations. All equipment shall be new and of current production of a national firm that manufactures generator sets and controls, transfer switches, and assembles the generator sets as a complete and coordinated system. There will be one (1) source responsibility for warranty, parts, and service through a local representative with factory-trained servicemen.

- I. Related Sections include the following:
 - 1. Division 26 Section "Transfer Switch" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.3 SYSTEM DESCRIPTION

- A. The electric power generating system shall have sufficient capacity under continuous standby operation including inrush allowance as specified within Contract documents or otherwise scheduled.
- B. Voltage: voltage, phasing and wire quantity characteristics as specified within Contract documents or otherwise scheduled.
- C. The system shall consist of a natural gas driven generator set which includes all controls, protection, output circuit breaker(s), wiring, and accessories for automatic start-stop operation.
- D. The generator set shall include the capability of automatically controlling generator set operation. After starting, the unit will attain rated speed and voltage, and accept rated load. Generator set speed shall be controlled by the engine governor, while generating output voltage regulation shall be a function of the generator automatic voltage regulator. Manual adjustment of generator speed and voltage shall be provided.
- E. The generator set start-stop sequence shall be initiated manually or automatically by closing or opening of a contact. The control system shall automatically engage the cranking motor, sense engine starting speed, disengage the motor and arm the engine protection circuit.
- F. The set shall immediately shut down in the event of over speed, low oil pressure, high water temperature and over crank. Cause of shutdown shall be indicated by a light annunciator. System logic shall prevent restart until fault is cleared.
- G. Provisions for manual shutdown in the event of an emergency shall be provided.
- H. Generator system shall be suitable for the maximum available fault current.
- I. Generator system shall restore power within 10 seconds of loss of normal power.
- J. Engine block heater. Thermostatically controlled and sized to maintain manufacturers recommended engine coolant temperature to meet the start-up requirements of NFPA-99 and NFPA-110, Level 2. Voltage shall be 120vAC.
- K. The engine exhaust silencer shall be coated to be temperature and rust resistant, rated for critical application. The silencer will reduce total engine exhaust noise by 25-35 dB(A).
- L. Remote annunciator panel enabling the generator status to be viewed remotely. This remote annunciator panel shall communicate with the generator controller via 2-conductor twisted pair serial bus. The panel shall be mounted at location shown on plans.

1.4 SYSTEM PERFORMANCE

- A. The power generating system shall conform to the following performance criteria:
 - 1. Rating - Engine brake horsepower shall be sufficient to deliver full rated generator set KW/KVA at the installation site when operated at rated rpm and equipped with all engine-mounted parasitic and external loads such as radiator fans and power generators.
 - 2. Start Time and Load Acceptance - Engines shall start, achieve rated voltage and frequency, and be capable of accepting load within 10 seconds when properly equipped and maintained.
 - 3. Block Load Acceptance - Transient response shall conform to ISO 8528 requirements.

1.5 QUALITY ASSURANCE

- A. The complete power generation system, including engine, generator, and controls shall be the product of one manufacturer who has been regularly engaged in the production of complete generating systems for at least 15 years. All components shall have been designed to achieve optimum physical and performance compatibility and prototype tested to prove integrated design capability. The complete system shall have been factory fabricated, assembled, and production tested.
- B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
 - 1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
- C. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
- E. 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.
- F. Comply with ASME B15.1.
- G. Comply with NFPA 37.
- H. Comply with NFPA 70.
- I. Comply with NFPA 110 requirements for Level 2 power supply system.
- J. Comply with UL 2200.
- K. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
- L. Noise Emission: Comply with applicable state and local government requirements for maximum noise levels due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.6 PROJECT 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 Owner no fewer than two days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.
- B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - 1. Ambient Temperature: -20 to 115 deg F
 - 2. Relative Humidity: 0 to 95 percent.
 - 3. Altitude: Sea level to 2400ft.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases for package engine. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 2 years or 2000 running hours from date of final startup of system and shall include repair parts, labor, reasonable travel expense necessary for repairs at the jobsite, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair.
 - 2. Submittals received without written warranties as specified will be rejected in their entirety.

1.9 RESPONSIBILITY

- A. Receiving the generator at the site and installing it in place
- B. Expanding the existing pad to fit the new generator size.
- C. Connecting the new generator to the existing power system.
- D. Connecting all control wiring to the existing transfer switches.
- E. Install the new battery charger.
- F. Installing and wiring a new remote annunciator.
- G. Communicating with the generator manufacturer to facilitate delivery, start-up, testing, and commissioning of the new generator system,

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer
 - 1. Kohler Co.; Generator Division.
- B. These requirements are intended to define a power generation system of proven type and design, current production and with all components commercially available.

2.2 ENGINE-GENERATOR SET

- A. Factory-assembled and tested prior to shipment.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation. Include lifting attachments.
 - 1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.
- C. Capacities and Characteristics:
 - 1. Power Output Ratings: Nominal ratings as indicated.
 - 2. Output Connections: Three-phase, four wire.
 - 3. Nameplates: Each major system component to identify manufacturer's name and address, and model and serial number of component.
- D. Generator-Set Performance(with Fire Pump):
 - 1. Steady-State Voltage Operational Bandwidth: 2 percent of rated output voltage from no load to full load.
 - 2. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
 - 3. Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.
 - 4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
 - 5. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
 - 6. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
 - 7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
 - 8. Start Time: Comply with NFPA 110, Type 10, system requirements.
 - 9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
 - a. Provide permanent magnet excitation (where required) for power source to voltage regulator.

10. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

- A. Fuel: Natural Gas
- B. Rated Engine Speed at 60 Hz. output: 1800 rpm.
- C. Lubrication System: The following items are mounted on engine or skid:
 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow with bypass valve to continue lubrication in the event of clogged filter media.
 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
 4. System shall utilize synthetic lubricants with compatible filtration, and compatible engine seals, approved by the engine manufacturer.
- D. Governor: Electronic (speed sensing) to control engine speed and transient load response within commercial and ISO 8528 tolerances. Governor will be selected, installed, and tested by the generator set manufacturer.
- E. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Heater and control voltage operate at 120vAC. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
- F. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
 1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 3. Expansion Tank (Where Required): Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
 4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
 - a. Rating: 50-psig maximum working pressure with coolant at 180 deg F and non-collapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- G. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
 1. Minimum sound attenuation of 25 dB at 500 Hz.
 2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 85dBA or less.

- H. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- I. Starting System: low voltage 12v with negative ground.
 - 1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum.
 - 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
 - 3. Battery: Adequate capacity within ambient temperature range to provide specified cranking cycle at least three times without recharging.
 - 4. Battery Cable: Size and length as recommended by engine manufacturer. Include required interconnecting conductors and connection accessories. The system shall be capable of starting engine within 10 seconds.
 - 5. Battery Compartment: Factory fabricated of corrosion resistant case with acid-resistant finish and thermal insulation. Include accessories required to support and fasten batteries in place.
 - 6. Battery-Charging Alternator: Solid-state voltage regulation.
 - 7. Batteries shall be maintenance free, lead acid type mounted near the starting motor.
 - 8. Battery warranty shall be the responsibility of the generator set manufacturer.

2.4 CONTROL AND MONITORING

- A. The engine mounted instrument panel shall consist of a shock-mounted formed, welded with corrosion resistant finish.
- B. Annunciation and controls shall conform to NFPA 110 Level 2.
- C. Provide English marked controls and indicators on panel as specified or otherwise required by manufacturer such as but not limited to the following:
 - 1. Gauges: AC meters, volts, amperes, frequency, water temperature, oil pressure, battery voltage and running time hour meter.
 - 2. Switches: AUTO-OFF-RUN selector switch
 - 3. Switches: Horn silence
 - 4. Switches: Voltage adjustment potentiometer
 - 5. Indicators: High Engine Temperature
 - 6. Indicators: Low Coolant Level
 - 7. Indicators: Low Oil Pressure
 - 8. Indicators: Overcrank
 - 9. Indicators: Overspeed
- D. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator

set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

- E. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gauges shall be grouped in a common control and monitoring panel. Refer to Contract documents for location of remote panel(s).
 - 1. Wall-Mounting Cabinet NEMA 1 (or otherwise noted) construction: rigid, self-supporting steel unit. Enclosure must be rated for area in which it's installed.
 - 2. Current and Potential Transformers: Instrument accuracy class.
 - 3. Generator overload.
- F. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
- G. Remote Alarm Annunciator: Comply with NFPA 99 and NEC 700. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface-mounting type to suit mounting conditions indicated.
- H. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with NEMA AB 1 and UL 489.
 - 1. Tripping Characteristic: Designed specifically for generator protection.
 - 2. Trip Rating: Matched to generator rating.
 - 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
 - 4. Mounting: Adjacent to or integrated with control and monitoring panel.
- B. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:
 - 1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
 - 2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
 - 3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.

4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.
- C. Ground-Fault Indication (Where Required): Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.6 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Enclosure: Exterior rated of dripproof construction.
- G. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
 1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
- H. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

2.7 OUTDOOR GENERATOR-SET SOUND ATTENUATING ENCLOSURE

- A. Description: Vandal-resistant, weatherproof corrosion resistant steel housing, wind resistant up to 100 mph with corner posts, uprights and headers. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. The roof shall aid in the runoff of water and include a drip edge. The enclosure shall be completely lined with not less than 1" thick, UL 94 HF-1 listed, sound deadening material. This material must be of a self extinguishing design. The critical silencer shall be included to further reduce the unit sound level. Instruments and control shall be mounted within enclosure.
 1. Louvers (When Equipped): Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
 2. Hinged Doors: With padlocking provisions.
 3. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
 4. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
 5. Muffler Location: External to enclosure. Exhaust silencer(s) shall be provided of the size as recommended by the manufacturer and shall be of critical grade to attenuate the sound to the level noted above. It shall be supplied with a flexible, seamless, stainless steel exhaust connection. A rain cap will be supplied to terminate the exhaust pipe. These components must be properly sized to assure operation without excessive back pressure when installed.

- B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
 - 1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
 - 2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

2.8 VIBRATION ISOLATION DEVICES

- A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
 - 1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators.

2.9 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.10 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
 - 1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
 - 2. Full load run using resistive load bank unit capable of providing a balanced 3-phase, delta-connected load to generator set at 100 percent rated-system capacity, at 80 percent power factor, lagging. Testing shall be in loads of 25 percent steps up to 100 percent load.
 - 3. Maximum power.
 - 4. Voltage regulation.
 - 5. Transient and steady-state governing.
 - 6. Single-step load pickup.
 - 7. Safety shutdown.
 - 8. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 PREDELIVERY INSPECTION

- A. Pre-delivery inspection must be performed by the system manufacturers' local dealer to insure no damage occurred in transit and all components, controls, and related generator assemblies are included as specified herein.

3.2 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.
- B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
- B. Install packaged engine generator with isolators having a minimum deflection of 1 inch on 4-inch- high concrete base. Secure sets to anchor bolts installed in concrete bases.
- C. Install devices furnished by manufacturer but include items not factory mounted.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in Division 23 Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
- C. Connect engine exhaust pipe to engine with flexible connector or otherwise directed by manufacturer installation requirements.
- D. Connect fuel piping to engines with valves, unions and flexible connector.
- E. Ground equipment according to Division 26 Section.
- F. Connect wiring according to Division 26.

3.5 IDENTIFICATION

- A. Identify system components according to Division 23 Section "Identification for HVAC Piping and Equipment" and Division 26 Section "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

- A. All consumables necessary for testing shall be furnished by the bidder. Any defects which become evident during the test shall be corrected by the bidder at his own expense prior to shipment to the jobsite.
- B. The complete installation shall be checked for procedural and operational compliance by a representative of the system manufacturer's authorized local dealer. The engine lubricating oil and antifreeze, as recommended by the system manufacturer, shall be provided by the generator set dealer. Any deficiencies shall be noted and corrected by the Contractor.

- C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- D. Perform tests and inspections and prepare test reports.
- E. Tests and Inspections:
 - 1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
 - 3. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks. Repair faulty devices and correct leaks conforming to manufacturer specifications.
 - 4. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
 - 5. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
 - 6. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge.
- F. Coordinate tests with tests for transfer switches and run them concurrently.
- G. Test instruments shall have been calibrated within the last 6 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- H. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- I. Test and adjust controls and safeties. Remove and replace malfunctioning units. Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel. Allocate minimum of 48 hours to cover topics such as but not limited to: control operation, schematics, wiring and diagrams, meters, indicators, warning lights, shutdown system, transfer switch operations and routine maintenance.

3.8 SERVICE MANUALS AND PARTS BOOKS

- A. The system manufacturer's authorized local dealer shall furnish copies each of the manuals and books listed below for each unit under this contract:
 - 1. OPERATING INSTRUCTIONS - with description and illustration of all switchgear controls and indicators and engine and generator controls.
 - 2. PARTS BOOKS - Illustrations listing all assemblies, subassemblies and components, except standard fastening hardware (nuts, bolts, washers, etc.).

3. PREVENTATIVE MAINTENANCE INSTRUCTIONS - on the complete system that cover daily, weekly, monthly, biannual, and annual maintenance requirements and include a complete lubrication chart.
4. ROUTINE TEST PROCEDURES - for all electronic and electrical circuits and for the main AC generator.
5. TROUBLESHOOTING CHART - covering the complete generator set showing description of trouble, probable cause and suggested remedy.
6. RECOMMENDED SPARE PARTS LIST - showing all consumables anticipated to be required during routine maintenance and test.
7. WIRING DIAGRAMS AND SCHEMATICS - showing function of all electrical components.

END OF SECTION 263213

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SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

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 lightning protection for building site components.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For air terminals and mounting accessories.
 - 1. Layout of the lightning protection system, along with details of the components to be used in the installation.
 - 2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.
- C. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.
- D. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.
- E. Field quality-control reports.
- F. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.
- G. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:
 - 1. Ground rods.
 - 2. Ground loop conductor.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Certified by LPI as a Master Installer/Designer, trained and approved for installation of units required for this Project.
- B. System Certificate:
 - 1. LPI System Certificate.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.5 COORDINATION

- A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
- B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.
- C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. Comply with UL 96 and NFPA 780.
- B. Roof-Mounted Air Terminals: NFPA 780, Class I copper unless otherwise indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Maxwell Lightning Protection
 - b. ERICO International Corporation.
 - c. Harger.
 - d. Heary Bros. Lightning Protection Co. Inc.
 - e. Independent Protection Co.
 - f. Preferred Lightning Protection.
 - g. Robbins Lightning, Inc.
 - h. Thompson Lightning Protection, Inc.
 - 2. Air Terminals More than 24 Inches Long: With brace attached to the terminal at not less than half the height of the terminal.
- C. Main and Bonding Conductors: Copper.
- D. Ground Loop Conductor: The same size and type as the main conductor except tinned.
- E. Ground Rods: Copper-clad 3/4 inch (19 mm) in diameter by 10 feet (3 m).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A and NFPA 780.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.
- C. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.
- D. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.
 - 1. Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.
- E. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.
- F. Bond extremities of vertical metal bodies exceeding 60 feet (18 m) in length to lightning protection components.
- G. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of area or item indicated.
 - 1. Bury ground ring not less than 24 inches (600 mm) from building foundation.
 - 2. Bond ground terminals to the ground loop.
 - 3. Bond grounded building systems to the ground loop conductor within 12 feet (3.6 m) of grade level.
- H. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot (18-m) intervals.

3.2 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

- A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.
- B. LPI System Inspection: Meet requirements to obtain an LPI System Certificate.

END OF SECTION 264113

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SECTION 265119 – LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 BIDDING INFORMATION

- A. In order to save time, the Owner has received proposals for various light fixtures as scheduled on the drawings. The Owner is evaluating proposals and will issue a purchase order to the successful bidder for the light fixtures.
- B. Subsequently, the Owner will award contract to an Electric Contractor for installation of the light fixtures and other associated electric work. The Electric Contractor will receive, will handle, will install and will assume the same responsibilities as though the contractor had initially invited proposals and made award on these light fixtures.
- C. The light fixtures shall be complete in all details, shall be factory assembled and tested and delivered F.O.B. Cincinnati, Ohio to a location specified by the Electric Contractor at a later date. The light fixture supplier shall include all freight charges in his bid. The successful Electric Contractor will accept light fixtures in Cincinnati, will deliver light fixtures to the building, will include in his bid all local freight, hauling and rigging, will furnish all necessary labor and supervision to install the light fixtures and place into operation.
- D. The start-up of the light fixtures shall be performed by the contractor and the cost of same shall be included in his proposal. All details of construction and installation shall meet the approval of the Engineer. Supplier shall provide, in addition, the operating instructions and the equipment operation and performance information as hereinafter specified.
- E. The entire installation shall comply with all local laws, laws of the State of Ohio, and the National Electrical Code.

1.2 SCOPE

- A. Contractor shall install all emergency and exit lighting fixtures as indicated in Fixture Schedule shown within Contract documents, and specified herein.
- B. All emergency and exit lighting fixtures are indicated within Contract documents with an identifying letter and number. Refer to the fixture schedule which identifies the light fixtures. On the light fixture schedule, note which fixtures are being pre-purchased by the owner and which fixtures shall be supplied by the contractor.

1.3 RELATED DOCUMENTS

- A. General provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.4 SUMMARY

- A. Section Includes:
 - 1. Interior solid-state luminaires that use LED technology.

1.5 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.

1.6 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.
- B. Shop Drawings
 - 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 herein.
- D. Samples for Verification: For each type of luminaire.
 - 1. Include Samples of luminaires and accessories to verify finish selection.

1.7 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.

1.8 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. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.

1.9 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.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.11 WARRANTY

- A. Warranty: Supplier shall agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five years parts and labor with no proration 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. Recessed Fixtures: Comply with NEMA LE 4.
- C. CRI of minimum 82. CCT of 3500 K.
- D. Rated lamp life of 50,000 hours based upon a minimum of compliance with IES TM.21 (LM-79/80/90).
- E. Lamps dimmable from 100 percent to 10 percent of maximum light output.
- F. Internal driver.
- G. Nominal Operating Voltage: 120V or 277V (Universal).

- H. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- I. Housings:
 - 1. Extruded-aluminum housing and heat sink.
- J. Fixtures must be DLC rated.

2.2 RECESSED LINEAR

- A. Minimum lumens and minimum allowable efficacy per schedule.
- B. Integral junction box with conduit fittings.

2.3 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:
 - 1. 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.
 - 2. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- D. Housings:
 - 1. Extruded-aluminum housing and heat sink.
- 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.

2.4 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Coordinate the following examination procedures with the successful electrical contractor.
- B. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- C. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate the following installation procedures with the successful electrical contractor.
- B. Comply with NECA 1.
- C. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- 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. 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.

3.3 FIELD QUALITY CONTROL

- A. Coordinate the following Field Quality Control procedures with the successful contractor.

- 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. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- C. Luminaire will be considered defective if it does not pass operation tests and inspections.
- D. Prepare test and inspection reports.

3.4 STARTUP SERVICE

- A. Provide factory trained technician to attend lighting demonstration.

3.5 ADJUSTING

- A. Coordinate the following adjusting of light fixtures with the successful contractor.
- B. 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 Engineer.

END OF SECTION 265119

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SECTION 265219 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 BIDDING INFORMATION

- A. In order to save time, the Owner has received proposals for various light fixtures as scheduled on the drawings. The Owner is evaluating proposals and will issue a purchase order to the successful bidder for the light fixtures.
- B. Subsequently, the Owner will award contract to an Electric Contractor for installation of the light fixtures and other associated electric work. The Electric Contractor will receive, will handle, will install and will assume the same responsibilities as though the contractor had initially invited proposals and made award on these light fixtures.
- C. The light fixtures shall be complete in all details, shall be factory assembled and tested and delivered F.O.B. Cincinnati, Ohio to a location specified by the Electric Contractor at a later date. The light fixture supplier shall include all freight charges in his bid. The successful Electric Contractor will accept light fixtures in Cincinnati, will deliver light fixtures to the building, will include in his bid all local freight, hauling and rigging, will furnish all necessary labor and supervision to install the light fixtures and place into operation.
- D. The start-up of the light fixtures shall be performed by the contractor and the cost of same shall be included in his proposal. All details of construction and installation shall meet the approval of the Engineer. Supplier shall provide, in addition, the operating instructions and the equipment operation and performance information as hereinafter specified.
- E. The entire installation shall comply with all local laws, laws of the State of Ohio, and the National Electrical Code.

1.2 SCOPE

- A. Contractor shall install all emergency and exit lighting fixtures as indicated in Fixture Schedule shown within Contract documents, and specified herein.
- B. All emergency and exit lighting fixtures are indicated within Contract documents with an identifying letter and number. Refer to the fixture schedule which identifies the light fixtures. On the light fixture schedule, note which fixtures are being pre-purchased by the owner and which fixtures shall be supplied by the contractor.

1.3 RELATED DOCUMENTS

- A. General provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.4 SUMMARY

- A. Section Includes:
 - 1. Emergency lighting units.
 - 2. Exit signs.

1.5 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.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of emergency lighting unit, 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.
- B. Shop Drawings:
 - 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 Verification: For each type of luminaire.
 - 1. Include Samples of luminaires and accessories to verify finish selection.
- D. Product Schedule:
 - 1. For emergency lighting units.
 - 2. For exit signs.

1.7 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.

1.8 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: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Luminaire-mounted, emergency battery pack: One for every 50 emergency lighting units. Furnish at least one of each type.
 - 3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.

1.9 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.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.11 WARRANTY

- A. Warranty: Supplier shall 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.
- B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Emergency Power Unit Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.

PART 2 - PRODUCTS

2.1 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.
- E. Comply with UL 1598 for fluorescent luminaires.
- F. Lamp Base: Comply with ANSI C81.61.
- G. Bulb Shape: Complying with ANSI C79.1.
- H. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.
 - 1. Emergency Connection: Operate two lamps continuously at an output of 1100 lumens each upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
 - 2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - 3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Less than 0 deg F or exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.
 - b. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
 - c. Humidity: More than 95 percent (condensing).
 - 4. Nightlight Connection: Operate lamp continuously at 40 percent of rated light output.
 - 5. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 6. Battery: Sealed, maintenance-free, nickel-cadmium type.

7. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
8. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
9. 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.

2.2 EMERGENCY LIGHTING

- A. General Requirements for Emergency Lighting Units: Self-contained units.
- B. Emergency Luminaires:
 1. Emergency Luminaires: As indicated on Lighting Fixture Schedule and described herein with the following additional features:
 - a. Operating at nominal voltage of 120 V ac or 277 V ac (universal).
 - b. Internal emergency power unit.
 - c. Rated for installation in damp locations, and for sealed and gasketed luminaires in wet locations.
 - d. UL 94 flame rating.
- C. Emergency Lighting Unit:
 1. Emergency Lighting Unit: As indicated on Lighting Fixture Schedule.
 2. Operating at nominal voltage of 120 V ac or 277 V ac (universal).
 3. Wall or ceiling with universal junction box adaptor.
 4. UV stable thermoplastic housing.
 5. Two Halogen lamp heads.
 6. Internal emergency power unit.

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. Operating at nominal voltage of 120 v AC or 277 v AC (universal).
 2. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
 3. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.

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:
 - 1. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 2. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- D. Housings:
 - 1. Poly-carbonite housing and aluminum heat sink.

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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Coordinate the following examination procedures with the successful electrical contractor.
- B. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- C. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- D. Examine walls and ceilings for suitable conditions where emergency lighting luminaires will be installed.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate the following installation procedures with the successful electrical contractor.
- B. Comply with NECA 1.
- C. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- D. Install lamps in each luminaire.
- E. Supports:
 - 1. Sized and rated for luminaire and emergency power unit 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.
- F. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls or attached to a minimum 20-gage backing plate attached to wall structural members or attached using through bolts and backing plates on either side of wall.
 - 2. Do not attach luminaires directly to gypsum board.
- G. 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 FIELD QUALITY CONTROL

- A. Coordinate the following Field Quality Control procedures with the successful contractor.
- B. 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.
- C. Luminaire will be considered defective if it does not pass operation tests and inspections.
- D. Prepare test and inspection reports.

3.4 STARTUP SERVICE

- A. Provide factory trained technician to attend lighting demonstration.

3.5 ADJUSTING

- A. Coordinate the following adjusting of light fixtures with the successful contractor.
- B. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:
 - 1. Inspect all luminaires. Replace lamps, emergency power units, 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 265219

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SECTION 269999 – DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

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. Fire-alarm control unit. Modify and expand if necessary.
 - 2. Manual fire-alarm boxes.
 - 3. System smoke detectors.
 - 4. Heat detectors.
 - 5. Notification appliances.
 - 6. Amplifiers.
 - 7. Remote annunciator.
 - 8. Addressable interface device.
 - 9. Control, monitor and signal modules.
- B. Scope of Work:
 - 1. The scope of work or this project is as follows:
 - a. In areas of the HVAC remodel, the fire alarm devices shall be upgraded one for one to addressable devices; the Fire Alarm sequence of operations shall not change.
 - b. Provide engineering for design of system and for the permit submittal package by NICET certified, state licensed, and manufacturer certified designer.
 - c. Application for permit including submittal package with system layout, wiring diagram, battery calculations, and devices cut sheets. Includes fees associated with the application for permit and acceptance testing during normal business hours.
 - d. Includes close out documents including as-built drawings, device cut sheets, and pertinent project information.
 - e. Includes performing acceptance testing with the authorities having jurisdiction during normal business hours.
 - f. Includes remodeled existing fire alarm control panel and furnish and install remote booster power supplies, if necessary for the distribution of power throughout the facility for addressable devices.

- g. Includes upgrading smoke detector devices to addressable type throughout the remodeled area of the facility.
- h. Includes furnishing addressable duct detector and intelligent relays in new HVAC unit.
- i. Includes programming for the fire alarm system to function in accordance with applicable local codes.
- j. Assumptions:
 - 1) Raceways, conductors, back boxes, and other installation infrastructure is existing and can be re-used if possible. If not possible, contractor shall install new.
 - 2) Elevator contractor will make any necessary connection from the fire alarm relays into the elevator control equipment.
 - 3) Elevator Contractor will install traveling cable to each speaker installed in elevator cars.

C. Description of Work

- 1. The contractor shall refurbish, replace where necessary, install, test, and place in operation a complete, double supervised, closed circuit fire and smoke detection and alarm system. All units of equipment shall be located as shown on the plans and wired in accordance with the manufacturer's instructions to make a complete and workable system. Note, the existing main fire control panel shall be reused and upgraded.
- 2. All units of equipment shall be Underwriters' Laboratories and Factory Mutual approved and listed and the entire installation shall comply with local and state codes, NFPA Standard 72, and shall be arranged to perform the functions hereinafter described and specified. In addition to the UL Listing on the individual components, the entire system, as installed, shall be UL Certified. A copy of the certification will be submitted to the owner after system is accepted.
- 3. The contractor shall reuse and refurbish the existing Fire Alarm Control Panel (FACP). The contractor shall furnish and install remote LCD annunciators (ANN), complete with network communication wiring system. Refer to the drawings.
- 4. When the contractor has completed the installation and refurbishment of the fire alarm system, he shall place the fire alarm system in operation and shall completely test the fire alarm system functions.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. NICET: National Institute for Certification in Engineering Technologies.

1.4 SYSTEM DESCRIPTION

- A. Noncoded, UL-certified addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.

1.5 SUBMITTALS

- A. General Submittal Requirements:

- 1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.

2. Shop Drawings shall be prepared and sealed by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified fire-alarm technician, Level IV minimum.
 - c. Licensed or certified by authorities having jurisdiction.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
 1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
 2. Include voltage drop calculations for notification appliance circuits.
 3. Include battery-size calculations.
 4. For duct detectors, include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
 6. Include equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
 7. Include floor plans to indicate final device locations of addressable device. Show size and route of cable and conduits.
- D. Delegated-Design Submittal: For smoke and heat detectors 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. Drawings showing the location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.
 2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.
- E. Qualification Data: For qualified Installer.
- F. Field quality-control reports.
- G. 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.

1.6 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 IV technician.
- C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.
- D. 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.
- E. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of fire-alarm service.
 - 2. Do not proceed with interruption of fire-alarm service without Owner's written permission.

1.8 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.9 EXTRA MATERIALS

- 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 for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
 - 2. Smoke Detectors and Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than 1 unit of each type.
 - 3. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no fewer than 1 unit of each type.
 - 4. Keys and Tools: One extra set for access to locked and tamperproofed components.
 - 5. Audible and Visual Notification Appliances: Two of each type installed.

6. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. FACP and Equipment:
 - a. Cintas Fire Protection
 - b. Notifier
 - c. Siemens Building Technologies Fire Division

(Refer to the bid form for alternate pricing requirements)

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
 1. Manual stations.
 2. Heat detectors.
 3. Smoke detectors.
 4. Duct smoke detectors.
 5. Fire-extinguishing system operation.
- B. Fire-alarm signal shall initiate the following actions:
 1. Continuously operate alarm notification appliances.
 2. Identify alarm zone at fire-alarm control unit and remote annunciators.
 3. Transmit an alarm signal to the remote alarm receiving station. System trouble signal initiation shall be by one or more of the following devices and actions:
 4. Open circuits, shorts, and grounds in designated circuits.
 5. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 6. Loss of primary power at fire-alarm control unit.
 7. Ground or a single break in fire-alarm control unit internal circuits.
 8. Abnormal ac voltage at fire-alarm control unit.
 9. Break in standby battery circuitry.
 10. Failure of battery charging.

11. Abnormal position of any switch at fire-alarm control unit or annunciator.
- C. System Trouble and Supervisory Signal Actions in bedrooms and suites: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators.

2.3 FACP (REFURBISH, MODIFY AND EXPAND EXISTING PANEL)

- A. General Description:
 1. Addressable control circuits for operation of equipment.
- B. Cabinet: Lockable steel red semi-surface mount enclosure unless prohibited in final area of location. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exact matching modular unit enclosure(s).
- C. Alphanumeric Display and System Controls: Panel shall include LCD or LED display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands.
- D. The system control panel, over its two wire multi-drop channel, must be capable of communicating with the types of addressable devices as specified. Addressable devices to be located as required per code, Authority of Jurisdiction and as shown within Contract documents.
- E. Circuits:
 1. Signaling Line Circuits: NFPA 72, Class B
 2. Notification-Appliance Circuits: NFPA 72, Class B
 3. Actuation of alarm notification appliances, annunciation, elevator recall and actuation of suppression systems shall occur within 10 seconds after the activation of an initiating device.
- F. Distributed Module Operation: FACP shall be capable of allowing remote location of the following modules; interface of such modules shall be through a Style 4 (Class B) supervised serial communications channel (SLC):
 1. Addressable Signaling Line Circuits
 2. Initiating Device Circuits
 3. Notification Appliance Circuits
 4. Auxiliary Control Circuits
- G. The FACP shall continuously perform an automatic self-test on each sensor which will check sensor electronics and ensure the accuracy of the values being transmitted. Any sensor that fails this test shall indicate a "SELF TEST ABNORMAL" trouble condition.
- H. FACP shall individually monitor sensors for calibration, sensitivity and alarm condition, and shall individually adjust for sensitivity. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values.
- I. Environmental Compensation: The FACP shall maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt and other conditions that could affect detection operations.
- J. Four (2) two form "C" Auxiliary Relay Circuits (Form C contacts rated 2A @ 24VDC, resistive), operation is programmable for trouble, alarm, supervisory of other fire response functions. Relays shall be capable of switching up to .5A @ 120VAC, inductive.

- K. Dual Municipal City Circuit Connection with disconnect switches for connection to either 24VDC Remote Station (reverse polarity) or local energy.
- L. Battery Meter Module providing ammeter and voltmeter for power supply monitoring. Voltage and ammeter readouts for charging battery circuits in the system shall be displayed on the FACP.
- M. One (1) Auxiliary electronically resettable fused 2A @ 24VDC Output, with programmable disconnect operation for 4-wire detector reset.
- N. One (1) Auxiliary Relay, SPDT 2A @ 32VDC, programmable as a trouble relay, either as normally energized or de-energized or as an auxiliary control.
- O. Remote Unit Interface: Supervised serial communication channel for control and monitoring of remotely located annunciators and I/O panels.
- P. Modular Network Communications Card.
- Q. Alarm Silencing, Trouble, and Supervisory Alarm Reset: Manual reset at the FACP and remote annunciators, after initiating devices are restored to normal.
 - 1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
 - 2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.
- R. Walk Test: A test mode to allow one person to test alarm and supervisory features of initiating devices. Enabling of this mode shall require the entry of a password. The FACP and annunciators shall display a test indication while the test is underway. If testing ceases while in walk-test mode, after a preset delay, the system shall automatically return to normal.
 - 1. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, trouble, and supervisory signals to a remote alarm station through a digital alarm communicator transmitter and telephone lines.

2.4 POWER REQUIREMENTS

- A. Fire alarm system is to provide sufficient battery capacity to operate the entire system upon loss of 120VAC power in a normal supervisory mode for a period of seventy-two (72) hours with 15 minutes of alarm operation at the end of this period. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operations shall be fully automatic with self diagnosing and indication.
- B. Power Supply for Supervision Equipment: Supply for audible and visual equipment for supervision of the ac power shall be from a dedicated dc power supply, and power for the dc component shall be from the ac supply.
- C. The incoming power to the system shall be supervised so that any power failure will be indicated at the control panel. A green "power on" LED shall be displayed continuously while incoming power is present.
- D. All circuits requiring system operating power shall be individually fused at the control panel.
- E. Provide new remote NAC/transponder panels as required per manufacture requirements. Electrical Contractor shall provide required power to each NAC panel. FAC to coordinate circuit requirements with EC.
- F. Primary Power: 24vDC obtained from 120vAC service and a power-supply module.
 - 1. The alarm current draw of the entire fire alarm system shall not exceed 80 percent of the power-supply module rating.
 - 2. Power supply shall have a dedicated circuit(s) for its connection. Circuit(s) shall be mechanically protects and identify as "FIRE ALARM SYSTEM POWER."

- G. Secondary Power: 24vDC supply system with batteries and automatic battery charger and an automatic transfer switch.
 - 1. Batteries: Sealed lead calcium.
 - 2. Battery and Charger Capacity: Comply with NFPA 72.
- H. Where required, provide intelligent remote battery charger for charging up to 110Ah batteries.
- I. Power Supplied with integral intelligent Notification Appliance Circuit Class B for system expansion.
- J. Surge Protection:
 - 1. Install TVSS protection on normal ac power input to each cabinet.
 - 2. Surge protection shall be phase to neutral, phase to ground with indication of normal and failed protection modules. Surge protection devices shall be approved by FACP manufacture.

2.5 SYSTEM SMOKE DETECTORS

- A. General Description:
 - 1. UL 268 listed, operating at 24vDC, nominal. Minimum operating temperature range: 32-120 deg F.
 - 2. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base.
 - 3. Integral Addressable Module: For the purpose of future upgrade smoke detectors are arranged to communicate detector status (normal, alarm, or trouble) to the FACP. Sensor base shall contain a LED that will flash each time it is scanned by the control panel (once every four (4) seconds). When the control panel determines that a sensor is in the alarm or a trouble condition, the control panel shall command the LED on that sensor's base to turn on steady indicating the abnormal condition. Sensors which do not provide a visible indication of an abnormal condition at the sensor location shall not be acceptable.
 - 4. Each sensor shall be scanned by the control panel for its type identification to prevent inadvertent substitution of another sensor type. The control panel shall operate with the installed device but shall initiate a "Wrong Device" trouble condition until the proper type is installed or the programmed sensor type is changed.
 - 5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 6. Each sensor shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
 - 7. The sensor's electronics shall be immune from false alarms caused by EMI and RFI.
- B. Multi-Sensors shall combine photoelectric smoke sensing and heat sensing technologies. An alarm shall be determined by either smoke detection, with selectable sensitivity from 0.25 to 3.5% obscuration; or heat detection, selectable as fixed temperature or fixed with selectable rate-of-rise; or based on an analysis of the combination of smoke and heat activity.
- C. Photoelectric Smoke Detectors:
 - 1. Sensor: LED or infrared light source with matching silicon-cell receiver.
 - 2. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.

3. Addressable smoke sensors shall be of the photoelectric type and shall communicate actual smoke chamber values to the system control panel.
 4. Unit assembly shall be documented as compatible with the control equipment to which it's connected and be listed for both ceiling and wall mount applications.
- D. Duct Mounted Smoke Detectors:
1. Photoelectric Smoke Detectors:
 - a. Sensor: LED or infrared light source with matching silicon-cell receiver.
 - b. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.
 - c. Duct detectors shall be rated for air velocities ranges available from air handling system.
 2. UL 268A listed, operating at 24vDC, nominal within a NEMA 4X weatherproof duct housing enclosure shall be provided for the circulation of conditioned air around the internally mounted addressable duct sensor housing to maintain the sensor housing at its rated temperature range. The housing shall be UL Listed to Standard 268A.
 3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
 4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The base shall be designed for mounting directly to the air duct. Base shall be capable of being monitored by an addressable adaptor module.
 5. Detector assembly shall be furnished with two (2) isolated alarm contacts rated 10amps at 250vAC.
 6. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
 7. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status. Provide remote status and alarm indicator and test station where indicated on contract documents.
 8. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
 9. Detector shall use a remote keyed testing station with led visual status indicators.
 10. Detectors upon activation shall alarm locally and remotely to fire alarm panel.
 11. Smoke detectors associated with air handling systems shall deactivate associated air handling systems and deliver a trouble signal to the central fire alarm panel. Detectors shall be provided with additional contacts for monitoring by the Building Automation System (BAS). Coordinate BAS requirements with Temperature Controls Contractor (TCC)
- E. Duct Smoke Detectors in concealed locations:
1. Remote Air Sampling smoke detection for duct systems.
 2. Includes air sampling piping network, sampling blower, control unit and photoelectric smoke detector.
 3. UL 268 listed, operating at 24 volts dc.

2.6 ADDRESSABLE APPLIANCES NAC POWER EXTENDER (IF NECESSARY)

- A. The addressable controller shall be a stand-alone panel capable of powering a minimum of 3 signaling line circuits. Each channel shall be rated for 2.5 amps and support addressable notification appliances. Power and communication for the notification appliances shall be provided on the same pair of wires.
- B. The internal power supply & battery charger shall be capable of charging up 12.7 Ah batteries internally mounted or 18Ah batteries mounted in an external cabinet.
- C. The NAC extender panel may be mounted close to the host control panel or can be remotely located.
- D. Cabinet color shall be red and identified as a component of the fire alarm system.

2.7 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Listed and labeled according to UL 632.
- B. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising 2 lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.
- C. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.
- D. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.8 ZONE ADAPTOR MODULE & INDIVIDUAL ADAPTOR MODULE (DUCT DETECTOR ONLY)

- A. An addressable interface module shall be provided for interfacing non addressable devices or equipment to an addressable fire alarm signaling line circuit. The device shall be a Zone Adaptor Module (ZAM) or an Individual Adaptor Module (IAM).
- B. ZAM's and IAM's will be capable of mounting in a standard outlet box. And will include cover plates. ZAM's will receive their 24VDC power from a separate two (2) wire pair running from the FACP power supply or appropriate source.
- C. There shall be two types of devices:
 - 1. Type 1: Monitor
 - a. For conventional 2-wire contact device monitoring with Style B wiring supervision. These ZAM's will communicate the zone's status (normal, alarm, trouble) to the FACP. ZAM's shall be used for monitoring of water flow, valve tamper, non-addressable detectors, self contained fire suppression systems, elevator or other equipment or devices required for reporting conditions to the FACP.
 - 2. Type 2: Control
 - a. For non-supervised control: This type of addressable device will provide double pole double throw relay switching for loads up to 120VAC. It will contain easily replaceable 2 amp fuse, one on each common leg of the relay.
- D. The ZAM & IAM modules shall be supervised and uniquely identified by the FACP. Device identification shall be transmitted to the control panel for processing according to the program instructions. Should the ZAM or IAM

become non-operational, tampered with, or removed, a discrete trouble signal, unique to the device, shall be transmitted to, and annunciated at, the control panel.

- E. The ZAM or IAM module shall be capable of being programmed for its “address” location on the addressable device signaling line circuit. The ZAM shall be compatible with addressable manual stations and addressable detectors on the same addressable circuit.
- F. All devices will be supervised for trouble conditions. The system control panel will be capable of indicating the type of trouble condition (open, short, device missing/failed). Should a device fail, it will not hinder the operation of other system devices. Should a problem occur on a particular wire run, it will not affect other wire runs.

2.9 WIRE AND CABLE

- A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.
- B. Installed in own conduit system per requirements of specification 260533 Raceway & Boxes.
- C. Signaling Line Circuits: Twisted, shielded pair sized not less than as recommended by system manufacturer.
 - 1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70 Article 760, Classification CI, for power-limited fire alarm signal service. UL listed as Type FPL, and complying with requirements in UL 1424 and in UL 2196 for a 2-hour rating.
- D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
 - 1. Low-Voltage Circuits: No. 16 AWG, minimum.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum.
- E. Wire or cable color shall be “red” unless otherwise restricted by manufacturer or applicable codes.

2.10 DRAWINGS AND SHOP DRAWINGS

- A. The system shall be installed in accordance with the Fire Alarm Designer drawings and with shop drawings for the specific installation as supplied by the manufacturer. The shop drawings shall be submitted to the Engineer, for his approval, prior to installation. The manufacture shall be responsible for producing any and all documentation required to obtain any permit, including Professional Engineer’s stamped drawings.
- B. The following shall be submitted to Xavier University, and turned over to the XU Department of Public Safety.
- C. Typical layout of all wall mounted equipment, either flush or recessed, accurately dimensioned. Each possible method of installation shall be illustrated. Three sets.
- D. Schematics and wiring diagrams showing all interconnection wiring. Three sets.
- E. A single line drawing showing the physical location of each device, its system address, and the type of device. A single line riser diagram of the system. Complete list of points on system, and all programming data for panel. Three sets.
- F. Layout of all equipment as it will be installed in the control panel(s). Three sets.
- G. Bill of material of all equipment. Three sets.
- H. Detain description of system operation as it will be installed, with only those features included that are used. Three sets.

- I. Reduced size (8.5" x 11") laminated single line drawing(s) on multiple sheets if necessary to preserve legibility, and list of points, as described in 5.3. One set in three ring binder, permanently labeled with the building name. To be placed in key and drawing cabinet (see 11).
- J. Revit compatible (.RVT) files of all drawings, point list file, and panel programming description, on media acceptable to Xavier University. Two sets.
- K. Service manuals for all components of the system. In three ring binders, three sets.
- L. General catalog sheets shall not be submitted in lieu of shop drawings. When illustrative of a series of products or variations of products, the one model or type intended to be used shall be clearly highlighted, and all non-pertinent description shall be crossed out.

2.11 WIRING AND BOX COLOR CODES

- A. For new construction installed by this contractor, all wiring and boxes shall be color coded as specified in NFPA 72 and the National Electrical Code. All pull and junction boxes will specifically be painted red.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Provide and install the system in accordance with the plans and specifications, all applicable codes and the manufacturer's recommendations.
- B. Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate subcontractors.
- C. Smoke Detector Spacing:
 - 1. Smooth ceiling spacing shall not exceed the rating of the detector.
- D. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.
- E. HVAC Controller: FAC to provide a FACP communication status signal to the HVAC direct digital DDC controller. The Electrical Contractor shall extend conduit and wiring from the FACP to the DDC system controller. Termination of wiring to the DDC controller shall be performed by the Temperature Control Contractor.
- F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of the duct. Duct detectors shall include (2) two relays for shutdown and (1) one for the DDC controller. Where duct detectors cannot be installed in compliance with the manufacturer's requirements remote sampling duct smoke detection for concealed locations shall be provided.
- G. Remote Status and Alarm Indicators: Install near each detector that is not readily visible from normal viewing position. Refer to plans for locations of remote status indicators.
- H. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor.

3.2 WIRING INSTALLATION

- A. Install wiring according to the following:
 - 1. NECA 1.
 - 2. TIA/EIA 568-A.
 - 3. NEC 760.

- B. Wiring Method:
 - 1. Where none exist, install wiring in metal raceway according to Division 26 Section 260533 "Raceway and Boxes".
 - 2. Where none exist, fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a new dedicated raceway system. This raceway system shall not be used for any other wire or cable. Fire alarm raceway including junction and mounting boxes shall be "RED" in color.
 - 3. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
 - 4. Cables and wiring terminations shall conform to respected Manufacturer and NFPA 70 installation requirements.
- C. Wiring within Enclosures:
 - 1. Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- D. Cable Taps:
 - 1. Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- E. Color-Coding:
 - 1. Where none exist, color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Electrical Identification"
- B. Install instructions frame in a location visible from the FACP.
- C. Label FACP source of power "FIRE ALARM" and provide mechanical means of protection in accordance with NFPA 70 and 72.

3.4 GROUNDING

- A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components, testing and adjustments of the system.
- B. Personnel associated with fire alarm system installation shall be qualified and experienced in the installation, code requirements, inspection, testing and maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to include, but shall not be limited to, individuals with the following qualifications:

1. Factory trained and certified.
 2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
 3. International Municipal Signal Association (IMSA) fire alarm certified.
 4. Certified by a state or local authority.
 5. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.
- C. Perform the following field tests and inspections and prepare test reports:
1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.
 2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters.
 3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
 4. Testing: Follow procedure and record results complying with requirements in NFPA 72.
 - a. Detectors that are outside their marked sensitivity range shall be replaced.
 5. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.

3.6 CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt and debris. Clean unit internally using methods and materials recommended by manufacturer. Cleaning shall be performed prior to any certification testing.

3.7 WARRANTY

- A. The contractor shall warrant the entire system, including existing wiring and devices, against mechanical and electrical defects for a period described in the contract general conditions. This period shall begin upon completed certification and testing of the system.
- B. The fire alarm system subcontractor or manufacturer shall offer for the owner's consideration at the time of system submittal a priced inspection, maintenance, testing and repair contract in full compliance with the requirements of NFPA 72.
- C. The owner shall have the option of renewing at the price quoted for single or multiple years up to five years.
- D. The contractor performing the contract services shall be qualified and listed to maintain ongoing certification of the completed system to the UL for specific installed system listing.
- E. The installation contractor shall furnish training as follows for a minimum of four employees of the system user:
1. Training in the receipt, handling and acknowledgment of alarms.
 2. Training in the system operation including manual control of output functions from the system control panel.

3. Training in the testing of the system including logging of detector sensitivity, field test of devices and response to common troubles.
4. The total training requirement shall be a minimum of 2 hours, but shall be sufficient to cover all items specified.

3.8 CERTIFICATE OF COMPLIANCE

- A. Complete and submit to the Project Engineer in accordance with NFPA 72, most current edition adopted by the Authority Having Jurisdiction.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 283111

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