PROJECT MANUAL

AC Installation Package - Averill & Lyons Elementary Schools
Lansing, MI

VOLUME I

Bid Package 2

Monday, November 28, 2022

Installation Package

CONSTRUCTION MANAGER

The Christman Company
208 N. Capitol Avenue
Lansing, MI 48933-1357
517-482-1488

Architect
C2AE
106 W. Allegan St. Suite 500
Lansing, MI 48933

Mechanical & Electrical Engineer
C2AE
106 W. Allegan St. Suite 500
Lansing, MI 48933

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Job #: 221125-010 Averill Elementary AC Project
3201 Averill, Dr.
Lansing, Michigan 48911

The Christman Company

Current Specifications

Number	Description	Revision	Issued Date	Received Date	Set
00 - Procurement and Contracting Requirements					
000110	Table of Contents	0			CD Set
01 - General Requirements					
013100	PROJECT MANAGEMENT AND COORDINATION	0			CD Set
013300	SUBMITTAL PROCEDURES	0			CD Set
02 - Existing Conditions					
024119	SELECTIVE DEMOLITION	0			CD Set
03 - Concrete					
033000	CAST-IN-PLACE CONCRETE	0			CD Set
04 - Masonry					
042000	UNIT MASONRY	0			CD Set
05 - Metals					
055000	METAL FABRICATIONS	0			CD Set
06 - Wood, Plastics, and Composites					
061000	ROUGH CARPENTRY	0			CD Set
07 - Thermal and Moisture Protection					
076200	SHEET METAL FLASHING AND TRIM	0			CD Set
077200	ROOF ACCESSORIES	0			CD Set
078413	PENETRATION FIRESTOPPING	0			CD Set
079200	JOINT SEALANTS	0			CD Set
09 - Finishes					
092216	NON-STRUCTURAL METAL FRAMING	0			CD Set
092900	GYPSUM BOARD	0			CD Set
096513	RESILIENT BASE AND ACCESSORIES	0			CD Set
096519	RESILIENT TILE FLOORING	0			CD Set
099123	INTERIOR PAINTING	0			CD Set
12 - Furnishings					
123216	MANUFACTURED PLASTIC-LAMINATE-CLAD CASEWORK	0			CD Set
23 - Heating, Ventilating, and Air Conditioning (HVAC)					
230513	Common Motor Requirements for HVAC Equipment	0	08/23/22		Equipment Package
230517	SLEEVES AND SLEEVE SEALS FOR HVAC PIPING	0			CD Set
230518	ESCUTCHEONS FOR HVAC PIPING	0			CD Set
230523	BALL VALVES FOR HVAC PIPING	0			CD Set

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Job #: 221125-010 Averill Elementary AC Project
3201 Averill, Dr.
Lansing, Michigan 48911

Number	Description	Revision	Issued Date	Received Date	Set
230523.14	CHECK VALVES FOR HVAC PIPING	0			CD Set
230548	Vibration and Seismic Controls for HVAC	0			CD Set
230553	IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT	0			CD Set
230593	TESTING, ADJUSTING, AND BALANCING FOR HVAC	0			CD Set
230713	DUCT INSULATION	0			CD Set
230719	HVAC PIPING INSULATION	0			CD Set
230800	COMMISSIONING OF HVAC	0			CD Set
230923.11	Control Valves	0			CD Set
230993.11	Sequence of Operations for HVAC DDC	0			CD Set
232113	HYDRONIC PIPING	0			CD Set
232116	HYDRONIC PIPING SPECIALTIES	0			CD Set
233113	METAL DUCTS	0			CD Set
233300	AIR DUCT ACCESSORIES	0			CD Set
233713.13	AIR DIFFUSERS	0			CD Set
238223	Unit Ventilators	1			CD Set
26 - Electrical					
260000	GENERAL ELECTRICAL REQUIREMENTS	0			CD Set
260001	ELECTRICAL SERVICE ENTRANCE	0			CD Set
260002	EQUIPMENT WIRING	0			CD Set
260501	MINOR ELECTRICAL DEMOLITION	0			CD Set
260519	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES	0			CD Set
260526	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS	0			CD Set
260529	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS	0			CD Set
260533.13	CONDUITS FOR ELECTRICAL SYSTEMS	0			CD Set
260533.16	BOXES AND COVERS FOR ELECTRICAL SYSTEMS	0			CD Set
260543	UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS	0			CD Set
260544	SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING	0			CD Set
260553	IDENTIFICATION FOR ELECTRICAL SYSTEMS	0			CD Set
262216	Low-Voltage Buck-Boost Transformers	0	08/23/22		Equipment Package
262413	Switchboards	0	08/23/22		Equipment Package
262416	Panelboards	0	08/23/22		Equipment Package
262816	ENCLOSED SWITCHES AND CIRCUIT BREAKERS	0			CD Set
28 - Electronic Safety and Security					
284621.11	ADRESSABLE FIRE-ALARM SYSTEMS	0			CD Set

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Job #: 221125-070 Lyons Elementary AC Project
2901 Lyons Ave.
Lansing, Michigan 48910

The Christman Company

Current Specifications

Number	Description	Revision	Issued Date	Received Date	Set
00 - Procurement and Contracting Requirements					
000110	Table of Contents	0	11/15/22	11/15/22	CD Set
01 - General Requirements					
013100	PROJECT MANAGEMENT AND COORDINATION	0	11/15/22	11/15/22	CD Set
013300	SUBMITTAL PROCEDURES	0	11/15/22	11/15/22	CD Set
02 - Existing Conditions					
024119	SELECTIVE DEMOLITION	0	11/15/22	11/15/22	CD Set
03 - Concrete					
033000	CAST-IN-PLACE CONCRETE	0	11/15/22	11/15/22	CD Set
04 - Masonry					
042000	UNIT MASONRY	0	11/15/22	11/15/22	CD Set
05 - Metals					
055000	METAL FABRICATIONS	0	11/15/22	11/15/22	CD Set
06 - Wood, Plastics, and Composites					
061000	ROUGH CARPENTRY	0	11/15/22	11/15/22	CD Set
07 - Thermal and Moisture Protection					
076200	SHEET METAL FLASHING AND TRIM	0	11/15/22	11/15/22	CD Set
077200	ROOF ACCESSORIES	0	11/15/22	11/15/22	CD Set
078413	PENETRATION FIRESTOPPING	0	11/15/22	11/15/22	CD Set
079200	JOINT SEALANTS	0	11/15/22	11/15/22	CD Set
09 - Finishes					
092216	NON-STRUCTURAL METAL FRAMING	0	11/15/22	11/15/22	CD Set
092900	GYPSUM BOARD	0	11/15/22	11/15/22	CD Set
096513	RESILIENT BASE AND ACCESSORIES	0	11/15/22	11/15/22	CD Set
096519	RESILIENT TILE FLOORING	0	11/15/22	11/15/22	CD Set
099123	INTERIOR PAINTING	0	11/15/22	11/15/22	CD Set
12 - Furnishings					
123216	MANUFACTURERED PLASTIC-LAMINATE-CLAD CASEWORK	0	11/15/22	11/15/22	CD Set
23 - Heating, Ventilating, and Air Conditioning (HVAC)					
230500	COMMON WORK RESULTS FOR MECHANICAL	0	11/15/22	11/15/22	CD Set
230513	Common Motor Requirements for HVAC Equipment	1	11/15/22	11/15/22	CD Set
230523	GENERAL-DUTY VALVES FOR PIPING	0	11/15/22	11/15/22	CD Set
230529	HANGERS AND SUPPORTS	0	11/15/22	11/15/22	CD Set

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Job #: 221125-070 Lyons Elementary AC Project
2901 Lyons Ave.
Lansing, Michigan 48910

Number	Description	Revision	Issued Date	Received Date	Set
230553	MECHANICAL IDENTIFICATION	0	11/15/22	11/15/22	CD Set
230593	TESTING, ADJUSTING, AND BALANCING	0	11/15/22	11/15/22	CD Set
230700	MECHANICAL INSULATION	0	11/15/22	11/15/22	CD Set
230900	INSTRUMENTATION AND CONTROL FOR HVAC	0	11/15/22	11/15/22	CD Set
231123	FACILITY NATURAL-GAS PIPING	0	11/15/22	11/15/22	CD Set
232213	STEAM AND CONDENSATE HEATING PIPING	0	11/15/22	11/15/22	CD Set
232216	STEAM AND CONDENSATE PIPING SPECIALTIES	0	11/15/22	11/15/22	CD Set
232300	REFRIGERANT PIPING	0	11/15/22	11/15/22	CD Set
233113	METAL DUCTS	0	11/15/22	11/15/22	CD Set
233300	AIR DUCT ACCESSORIES	0	11/15/22	11/15/22	CD Set
233423	HVAC POWER VENTILATORS	0	11/15/22	11/15/22	CD Set
233713	DIFFUSERS, REGISTERS, AND GRILLES	0	11/15/22	11/15/22	CD Set
233723	HVAC GRAVITY VENTILATORS	0	11/15/22	11/15/22	CD Set
233813	COMMERCIAL-KITCHEN HOODS	0	11/15/22	11/15/22	CD Set
236200	PACKAGED COMPRESSOR AND CONDENSER UNITS	0	11/15/22	11/15/22	CD Set
237423	FUEL-FIRED MAKEUP-AIR UNITS	0	11/15/22	11/15/22	CD Set
238126	SPLIT-SYSTEM AIR-CONDITIONERS	0	11/15/22	11/15/22	CD Set
238223	Unit Ventilators	0	08/23/22		Equipment Package
26 - Electrical					
260010	GENERAL REQUIREMENTS FOR ELECTRICAL SYSTEMS	0	11/15/22	11/15/22	CD Set
260500	COMMON WORK RESULTS FOR ELECTRICAL	0	11/15/22	11/15/22	CD Set
260519	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES	0	11/15/22	11/15/22	CD Set
260526	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS	0	11/15/22	11/15/22	CD Set
260529	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS	0	11/15/22	11/15/22	CD Set
260533	RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS	0	11/15/22	11/15/22	CD Set
260543	UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS	0	11/15/22	11/15/22	CD Set
260553	IDENTIFICATION FOR ELECTRICAL SYSTEMS	0	11/15/22	11/15/22	CD Set
260573	OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY	0	11/15/22	11/15/22	CD Set
262216	Low-Voltage Buck-Boost Transformers	0	08/23/22		Equipment Package
262413	Switchboards	0	08/23/22		Equipment Package
262416	Panelboards	0	08/23/22		Equipment Package
262726	WIRING DEVICES	0	11/15/22	11/15/22	CD Set
262813	FUSES	0	11/15/22	11/15/22	CD Set
262816	ENCLOSED SWITCHES AND CIRCUIT BREAKERS	0	11/15/22	11/15/22	CD Set
262913	ENCLOSED CONTROLLERS	0	11/15/22	11/15/22	CD Set
269999	ELECTRICAL TESTING	0	11/15/22	11/15/22	CD Set

SECTION 00025

Project:	**AC Installation Package - Averill & Lyons Elementary Schools** Replacing unit ventilators at Averill Elementary and Lyons Elementary.
Owner:	**Lansing School District** 519 W Kalamazoo St Lansing, MI 48933
Architect/Engineer:	**C2AE** 106 W. Allegan St. Suite 500 Lansing, MI 48933
Construction Manager:	The Christman Company 208 N. Capitol Avenue Lansing, MI 48933-1357 517-482-1488

Lansing School District will receive sealed proposals for all work categories as described in the Project Manual for the Lansing School District Project: SB-0051 Averill & Lyons Elementary Mechanical Improvements. Proposal must be received at the Lansing School District Purchasing Office, ATTN: Jon Laing, 519 W. Kalamazoo St., Room 208 Lansing, Michigan before **Thursday, December 15, 2022 at 2:00 PM**. The Lansing School District will not consider late, faxed or electronic mail bids. Bids will be opened publicly and read aloud. All bids must be presented on the forms provided in the contract documents. Duplicate proposals shall be included in the sealed envelope clearly marked **WORK CATEGORY NO._____,** and shall be identified with the project name, work category name and the bidder's name and address.

All bids must be accompanied by a sworn and notarized Familial Relationship Affidavit, disclosing any familial relationship that exists between the owner or any employee of the bidder and any member of the Lansing School District Board of Education or the Superintendent. A bid security bond of 5% is required to be submitted with each bid. The Bid Security of the Bidders under consideration will be returned immediately after award of contracts. The amount of the guarantee shall be forfeited if the successful Bidder fails to enter into a contract and furnish required bonds and insurance within 30 days after award of contracts. All proposals submitted shall remain valid for a period of sixty (60) days after the bid date.

All questions are to be directed to the Construction Manager. No direct contact with the Owner or Architect is requested. **All questions need to be emailed to projects@lansingschools.net no later than 12/6/22 at 5:00pm.**

To obtain a copy of the bidding documents, please visit either the School District's Purchasing

Department's website (www.lansingschools.net), the State of Michigan's SIGMA Vendor Self Service website (https://sigma.michigan.gov) or the Builder's Exchange website (www.bxlansing.com). You can also contact the Lansing School District Purchasing Office at (517) 755-3030 for more information on where bid documents can be viewed.

All contractors bidding on work must be bondable and must include in their bid the cost for furnishing a Co-Obligee Labor and Material Payment Bond and a Co-Obligee Performance Bond. On the proposal form the contractor will identify a cost to be added from their bid should bonds be required.

There will be a virtual pre-bid conference on Thursday, December 1, 2022 at 10:00 AM conducted by the Construction Manager. It is strongly recommended that contractors attend the pre-bid conference. The call in information is below.

Microsoft Teams meeting

Join on your computer, mobile app or room device
Click here to join the meeting
Meeting ID: 282 837 613 918
Passcode: w35dKm
Download Teams | Join on the web
Join with a video conferencing device
130098559@teams.bjn.vc
Video Conference ID: 116 538 414 6
Alternate VTC instructions
Or call in (audio only)
+1 517-325-9971,,48729359# United States, Lansing
Phone Conference ID: 487 293 59#
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There will be site visit to both Averill and Lyons Elementary. Lyons Elementary will be open to the bidding contractors on 12/2/22 from 7:00 – 8:15am. Averill Elementary will be open to the bidding contractors on 12/5/22 from 7:00 – 8:15am.

END OF SECTION 00025

ARTICLE 1, SCOPE OF PROPOSALS

1.1 This is a "Construction Manager Project" for which The Christman Company is the "Construction Manager" For this portion of this project the successful bidders will become "Trade Contractors" and will enter into "Trade Contracts" with the Construction Manager. The Construction Manager will administer separate Trade Contracts for all Work Categories involved in the project. The project will be controlled, coordinated, and scheduled by the Construction Manager on behalf of the Owner.

1.2 Provisions shall be such that the Trade Contractor will assume the Construction Manager's obligations to the Owner for the portion of the work performed by each Trade Contractor.

1.3 Proposals: Separate proposals for the Work Categories included in this phase of the construction will be received by the Construction Manager. The time and place where proposals shall be received and a listing of the Work Categories included in this phase of the work are included in the Advertisement for Bids.

ARTICLE 2, BIDDER'S REPRESENTATION

2.1 Each Bidder by making his bid, represents that he has read and understands the bidding documents, and that they visited the site and familiarized himself with the local conditions under which the work is to be performed. No plea of ignorance of conditions that exist, or of any other relevant matter concerning the work to be performed in the execution of the work will be accepted as justification for failure to fulfill every detail of all the requirements of the Contract Documents. The Bidder, if awarded the Contract, shall not be allowed any extra compensation by reason of any matter or thing concerning which such Bidder did not fully inform himself prior to the bidding.

ARTICLE 3, BIDDING PROCEDURES

3.1 Proposals shall be submitted in duplicate, only on the forms provided by the Construction Manager, all blank spaces shall be fully filled in, including Addenda, Alternates, Price Breakouts, Unit Prices and Bidder's Certificate where applicable. All designations and prices shall be fully and clearly set forth with the amount of the bid stated in words and repeated in numerical figures. In cases of variations, the worded amount shall prevail. Erasures or other changes in the bid shall bear the signature of the Bidder. Insert N/A in those blanks on the Proposal Form that are not applicable. Separate Proposal Forms shall be prepared for each Work Category.

3.2 The bids shall be on the basis of a Lump Sum. Proposals shall not contain any added recapitulation of the work to be done as otherwise the proposal may be declared irregular. Oral, telegraphic or telephonic modifications of the work and/or the bid amounts shall not be considered.

3.3 The Architect or Construction Manager will make clarifications and corrections by the issuance of an addendum to all Bidders recorded in the Construction Manager's office as having in their possession a set of bidding documents. Addenda shall also be issued to all plan rooms in

which bidding documents are on file.

3.4 It shall be the responsibility of the Bidders on record to provide all of their prospective sub-bidders with the information contained in any addenda.

3.5 Duplicate proposals shall be submitted in an opaque envelope, clearly marked "PROPOSAL FOR WORK CATEGORY NO. _____, and shall be identified with the Project Name and the Bidder's name and address.

3.6 Proposals for this phase of the work will be received at the time and place indicated in the "Advertisement for Bids".

3.7 An award of Contracts: Each Work Category or combination of Work Categories will be awarded based on the dollar value of the proposal, qualifications of the Contractor, his ability to perform the work, and in the best interest of the Owner.

ARTICLE 4, EXAMINATION OF THE SITE

4.1 Each Bidder shall carefully examine the site of the project and surrounding territory; the means of approach to the site, and the structure of the ground, and make all necessary investigations required to inform himself thoroughly and fully as to facilities for delivering, storing, placing and handling of materials and equipment, and to inform himself fully as to all difficulties that may be encountered in the complete execution of all work in accordance with the Contract Documents.

4.2 Should a bidder find apparent discrepancies in, or omission from the Contract Documents, or should he be in doubt as to their true meaning, or should he have any questions regarding any work or material intended, then such Bidder, either Trade Contractor or Trade Subcontractor, shall submit to the Architect, through the Construction Manager, a written request for an interpretation thereof. The person submitting the request shall be responsible for its prompt delivery and such request must be delivered to the Architect by the Construction Manager at least five days before the opening of proposals.

4.3 Any verbal information obtained from, or statements made by a representative of the Owner, Architect, or the Construction Manager at the time of examination of the Contract Documents or Site shall not be construed as in any way amending the Contract Documents. Only such corrections or addenda as are issued in writing to all Bidders shall become a part of the Contract. Neither the Owner, the Architect, nor the Construction Manager shall be responsible for verbal instructions.

ARTICLE 5, MODIFICATION OR WITHDRAWAL OF BID

5.1 Bids submitted prior to the time and date designated for receipt of Bids may be modified or withdrawn only by notice to the party receiving Bids. Such notice shall be in writing over the signature of the Bidder, and must be received prior to date and time set for receipt of Bids. Any modification shall be so worded as not to reveal the amount of the original Bid.

ARTICLE 6, REJECTION OF BIDS

6.1 The Bidder acknowledges the right of the Construction Manager, Architect, and Owner to reject any or all bids, and to waive any informality or irregularity in any bid received, or to accept any bid which in the opinion of the Construction Manager, Architect, and Owner shall serve their best interests. In addition, the Bidder recognizes the right of the Construction Manager, Architect, and Owner to reject a bid if the Bidder failed to submit on the date and time required by the bidding documents, or if the bid is in any way incomplete or irregular, including a bid security, if required, is not received with the bid proposal.

ARTICLE 7,
PERFORMANCE CO-OBLIGEE BOND
AND LABOR & MATERIAL PAYMENT CO-OBLIGEE BOND
OWNER AND CONSTRUCTION MANAGER

7.1 The Construction Manager may, prior to the execution of the Contract, require the successful Bidders to furnish Co-obligee bonds, written in favor of the Owner and the Construction Manager, covering the faithful performance of the Contract and the payment of all obligations arising thereunder in an acceptable form to the Owner and the Construction Manager, and with such sureties secured through the Bidder's usual sources as long as the surety is licensed to do business in the State of Michigan and holds a minimum "A.M. Best" rating of A. Bonds shall be in the amount of 100% of the Contract sum. The premium for such bonds shall be paid by the Bidder. A space has been provided on the Proposal Form for the Bidders to indicate the amount that shall be deducted from their proposals if Bonds are not required. Should they be required, the Bidder shall deliver the bonds to the Construction Manager not later than the date of execution of the Contract.

7.2 The Bidder shall require the attorney-in-fact who executes the bonds on behalf of the surety, to affix thereto a certified and current copy of his power of attorney indicating the monetary limit of such power.

ARTICLE 8, VARIATIONS FROM MATERIALS SPECIFIED

8.1 Wherever materials are specified using names of specific manufacturers, the purpose is to establish a standard of quality and design, and not to limit competition. Contractors desiring to use materials of manufacturers other than those specified, shall indicate such material, manufacturer, and change of price, if any, in the space provided under the heading "Variations from Materials Specified" on the Proposal Forms. BASE BID PROPOSALS SHALL INCLUDE ONLY MATERIALS SPECIFIED. Variations, if accepted, shall be incorporated in the Contract, and the Contract Price adjusted accordingly, and no other materials shall be allowed accept upon written authorization of the Architect, Construction Manager, and Owner.

ARTICLE 9, THE CONTRACT FORM

9.1 Unless otherwise provided in the Bidding Documents, the Agreement for the Work shall be between the Trade Contractor and the Construction Manager on the contract form referenced

in the Standard form section of the Project Manual (The Christman Company subcontract agreement). By submitting your bid the Trade Contractor fully agrees to accept **ALL** terms and conditions of The Christman Company Subcontractor Agreement without modification.

ARTICLE 10, TIME OF COMPLETION

10.1 Each Bidder, as evidenced by submitting a proposal, shall agree to abide by the construction schedule dates as indicated in the Contract Documents, as developed during the post bid interview, scheduling meetings, and as required by Construction Manager. **The completion schedule for this project shall be met without exceptions.**

ARTICLE 11, QUALIFICATION OF BIDDER

11.1 The Owner, Architect, and Construction Manager may make such investigations as they deem necessary to determine the ability of the Bidder to perform the work, and the Bidder shall furnish all such information and data for this purpose as the Construction Manager may request within 24 hours, including a list of projects completed, a financial statement, organization of the firm, etc. The Owner reserves the right, based on the advice of the Construction Manager and Architect, to reject any bid if the evidence submitted by, or investigation of such Bidder fails to prove that such Bidder is properly qualified to carry out the obligations of the contract and to complete the work contemplated therein.

ARTICLE 12, TAXES AND CONTRIBUTIONS

12.1 It is understood that the bid prices stated shall include all applicable Federal, State or other Governmental Division taxes and assessments. Also, all contributions for unemployment compensation, health and welfare, old age benefits or other purposes now or hereafter effective during the term of the contract, and the Owner and Construction Manager shall not be liable for any additional charges therefore.

ARTICLE 13, WARRANTY

13.1 All work shall be guaranteed for a period of at least one (1) year and/or as more specifically stated in the contract documents after final payment but not earlier than substantial completion as determined by the Architect, and all service within that period shall be rendered without charge to the Owner.

END OF SECTION

00201 - The Construction Manager will be located at 208 N. Capitol Avenue, Lansing, MI 48933-1357 for questions regarding this Bid Package. Any questions regarding information contained in this Project Manual will be answered following a written request to the Architect through the Construction Manager, and clarified in an addendum. **Under no circumstances should any prospective bidder call the Owner or Architect for clarification of the Bidding Documents.**

00202 - AIA CONTRACT FORMS

Sample AIA Documents are available for review and reference in the Construction Manager's Main Office.

00203 - AIA STANDARD FORM FOR GENERAL CONDITIONS

AIA Document A201\2007, "General Conditions of the Contract for Construction as modified for this project," is available for review at the Construction Managers Main Office.

00205 - PRELIMINARY CONSTRUCTION SCHEDULE NARRATIVE

1. Time is of the essence on this project. The Project sequencing will be scheduled by the Construction Manager and must be adhered to by all Trade Contractors. Time, labor, material, equipment and possible cost implication of this sequencing and others not fully conceived or described prior to the time of bidding, shall be included in base bid.

   A preliminary schedule is included for reference only. It is emphasized that start dates for work may shift. The bidder shall familiarize himself with expected maximum durations and shall include in his proposal sufficient manpower to meet these requirements. All milestone dates are approximate and are to be used as guidelines for the Trade Contractor’s basis for bid.

2. The project will start 6/15/23 and be substantially complete by 8/21/23.

3. It is the Trade Contractor's responsibility to establish which items of work within the scope of his work category will be affected by the Owner's or other Trade Contractors operations and coordinate and schedule completion of his work accordingly at no cost to the Owner.

END OF SECTION 00200

The Work Category (W.C.) Description is included as a guide for Prospective Bidders to summarize the scope of work involved with the work category. The description included is **not** a final summary of the scope of work and should not be construed as such. **All** Contract Documents should be used, as a reference in preparing the Bid Proposal and any omissions in the proposal does not relieve the successful bidder of the responsibility to perform this work. Sections in **black** text are in reference to both Averill & Lyons. Sections in **red** text are in reference to Averill only. Sections in **blue** text are in reference to Lyons only.

W.C. No.	Category Description	Specification Reference
20	General Carpentry/Millwork/Doors	Division 00, Division 01, 024119, 033000, 042000, 055000, 061000, Division 07, 096513, 096519, 123216
21	Plaster/Drywall/Acoustical/Insulation	Division 00, Division 01, 024119, 078413, 079200, 092216, 092900
24	Painting & Vinyl Wall Covering	Division 00, Division 01, 079200, 099123
27	Mechanical Systems	Division 00, Division 01, 024119, 079200, Division 23
28	Electrical Systems	Division 00, Division 01, 024119, 079200, Division 26, Division 28

Work Category No. 00 – General Requirements for All Subcontractors

Work Included:

1. All permits, fees, inspections and approvals required by governing jurisdictions are included within base bid. Coordinate well in advance (at least 24 hours), required inspections and testing with the Construction Manager. This will include liaison between state and local agencies to ensure code compliance and for securing approval for the facility.
2. Excessive noise and vibration creating equipment shall be prohibited within close proximity of existing Structures/Buildings or occupied spaces. All proposed equipment scheduled for project shall be reviewed with the Construction Manager prior to delivery onsite.
3. Cleanup is required on a daily basis, and/or as directed by the Construction Manager. Cleanup dunnage, shipping materials and associated materials/debris generated from installation and dispose of properly. At no time will shipping containers, crates, materials, piles of debris, tarps, boxes, etc. be left on site, un-attended and unsecured, subject to unsafe conditions (i.e. access, fire and slip hazards and wind blown debris).
4. At least two (2) weeks prior to starting on-site, meet with the Construction Manager, Architect and Engineer to discuss and resolve any issues relating to status of material procurements, site conditions, access, staging/storage requirements, safety, testing, sequencing and scheduling of work.
5. Any work that could interfere with existing owners operation, i.e. use of certain roads, parking lots, access to buildings, shall require pre-task planning with the Construction Manager and shut-down notification requests shall be prepared (72) hrs in advance of any work being scheduled. Pre-task planning shall review and discuss scheduling, coordination with Owner operations, working durations, safe practices and procedures.
6. Protect existing structures, equipment, and finishes, including new work in place, from damage during the performance of this work category. Any protection removed to facilitate other work shall be reinstalled / replaced by the trade needing access.
7. Include all layout and engineering for each work category. Unless otherwise indicated in Section 00210, two control lines and one bench mark will be provided by the Construction Manager for Trade Contractor use.
8. Prior to commencing with installation, verify all field conditions and measurements and report any discrepancies to the Construction Manager.
9. Whenever possible all embeds to be furnished to other trades shall be fabricated / modified by the providing contractor with holes / tabs, etc to allow easy for installation by the installing contractor.
10. Provide full-time on-site supervision during the performance of your work. Supervision will be responsible for coordination, scheduling, safety, manpower, and other activities necessary to achieve safety, quality and scheduling requirements set forth under this work category. Supervision shall not be removed from this project without prior written consent and approval of the Construction Manager.
11. Full compliance with all site specific rules and regulations, including (but not limited to) OSHA, State Authorities, Local Authorities, and the Construction Manager. This subcontractor shall submit, prior to performing any work on-site, a copy of their site specific safety program/manual.

12. Should Subcontractor require on-site trailer or storage units, Subcontractor shall obtain approval from the Construction Manager on size, count and where to locate, prior to delivery on-site. Subcontractor to arrange and pay for service to trailers, including (but not limited to) electrical, phone, etc.

13. For material deliveries, if traffic control is required, Subcontractor to arrange manpower accordingly and provide signage, barricading, flagman etc., necessary for the safe performance of own work and protection of the public. Staging, storage on-site, and all deliveries required to support this installation must be reviewed and approved in advance by the Construction Manager.

14. Furnish and receive all required materials and deliver FOB jobsite. All deliveries shall be closely coordinated with the Construction Manager and 72 hour advance notice shall be given prior to delivery. Unless noted otherwise, deliveries must be coordinated to be complete with unloading during normal working hours.

15. This subcontractor will receive and handle all respective material and properly store/protect before, during and after installations. Excessive and out-of-sequence deliveries will be prohibited and subject to re-handling and removal offsite as directed by the Construction Manager.

16. Unless noted otherwise in Section 00210, furnish all hoisting, lifting, scaffolding, and handling to complete your own work.

17. Hoisting of materials and equipment over occupied areas will not be permitted, unless areas below are vacated or occupancy access is controlled during lifting. Each subcontractor will be required to notify Construction Manager seven (7) days in advance of required hoisting over occupied areas. Pre-Task planning and shut-down notifications will be required to assure minimum interruptions to Owner operations. In general, any hoisting equipment required to be used on-site must be reviewed in advance with Construction Manager for coordination of site logistics, safety procedures (including FAA approvals if required), access, lift swing areas, duration and overall activities relating to this hoisting equipment.

18. Approved O&M manuals are required at least 2 weeks prior to equipment start-up, start of warranty, and Owner training, but no later than thirty (30) days prior to substantial completion.

19. In the event of any jurisdictional or labor issues, the subcontractor assigned the work shall arrange to complete all work as required to avoid any interruptions/continuity of work on this project at no additional cost. All labor requirements pertaining to the project will be met.

20. Cooperate fully with representatives from Architect, Engineer, Owner, Construction Manager and independent testing agency, and allow for in progress inspections, including providing access to areas of work, when required.

21. This project may require multiple phases, which will require re-mobilization. All costs for multiple phasing shall be included.

22. Each Trade Contractor shall assume full responsibility for all pre-ordered products after their arrival at this designated location. This includes transportation, storage, start-up, warranty services, and installation in accordance with the General Conditions unless otherwise specified.

23. Critical Scheduling and Sequencing of Work:

    The Construction Manager shall provide overall scheduling and coordination for the entire project. All Trade Contractors shall acknowledge the Construction Manager's right to establish and set up, or subsequently modify the sequencing and scheduling of all work on this project for the earliest completion and/or benefit to the Owner. More restrictive sequencing to coordinate the Owner's on-going operations and/or for the coordination of the various trades shall be spelled out by the Work Category descriptions or as otherwise directed by the Construction Manager. All Trade Contractors agree to cooperate and alter their operations to maintain these more specified restrictions and sequences of the work.

    A. Subcontractor agrees to work concurrently with other subcontractors and the Construction Manager, according to the Master Project Schedule.

    B. Subcontractor shall confirm fabrication lead times, installation durations and sequencing for their Work in writing within two weeks of award, and report any discrepancies to Construction Manager.

    C. Scheduling updates and proper coordination and communication with other trades shall be accomplished as follows:

        - Weekly sub-progress meetings
        - Safety meetings, BIM meetings, scheduling meetings, pre-installation meetings, etc.

24. Construction Waste Management And Disposal – Review Spec Section 017419 Construction Waste Management And Disposal

25. General Commissioning Requirements – Review Spec Section 019113 General Commissioning Requirements.

26. Indoor Air Quality Management Plan – During Construction. Comply with site specific IAQ Management Plan for this project.

End of Work Category No. 00

Work Category No. 20 – General Trades

Work Included:

The subcontractor shall timely perform all work as detailed below, in accordance with the contract documents (including Bidding Requirements, Proposal Section, Contract Forms, General Conditions, Supplemental Conditions, General Requirements, Addenda, etc.), including, but not limited to, the following Specification Sections and Work Scope Items. Unless otherwise noted, this contractor is responsible for all items specified in the following specifications sections:

Reference W.C. Index and Cross Reference

Work Category Notes:

1. Complete all exterior and interior Carpentry/Millwork (rough and finish) and various General Trades Work as noted within this Work Category, including all labor, materials and equipment required for a complete installation.
2. All exterior and interior rough and finish carpentry including counters, cabinets, trim, nailers, blocking and plywood sheathing.
3. Furnish and install wood blocking, FRT, sheets, boards, plywood, etc. for required materials that are to be installed by this work category.
4. If in-wall backing/blocking is required by a specific manufacturer for products included as part of this Work, though not specifically shown within the documents, i.e. architectural millwork, wall trim, visual display surfaces, misc. accessories, etc., Subcontractor to furnish and install blocking for a complete installation.
5. Furnish and install all wood blocking in gypsum walls as required for cabinets, owner furnished items, etc. Also furnish and install all roof required nailers/blocking.
6. Furnish and install concrete expansion joints and associated fire stop as specified. Shop drawings required immediately for this work.
7. Provide non-combustible wood blocking in walls for wall mounted accessories and equipment installed by Owner/others shown or specified.
8. Furnish and install doors, frames, and hardware. Electric strikes, magnetic hold-opens, power transfer units will be installed by others – WC-28. Coordinate deliveries, installation instructions & wiring diagrams directly with WC-28. Card readers and power supply, shall be furnished and installed by Owner.
9. Manufacturer's rep is to review, approve and sign off on the installation of all door hardware before acceptance by TCC and the Owner.
10. All interior finish carpentry, architectural woodwork, metal countertops, shelving and millwork. Provide all sealants to adjacent surfaces, including dissimilar materials. Coordinate counter top support spacing with WC 27 under lavatory guards and lavatory installation.
11. Furnish and install all window sills.
12. Furnish and install all solid-surface materials and grommets as indicated.
13. All architectural hardware for cabinets supplied by this Work Category.
14. Include all stainless steel required and associated with millwork.

15. All fabricated materials are to be shop assembled to the greatest extent possible before shipping to the job site.

16. Furnish and installation of specialties including but not limited to: shelving, bulletin boards, broom / mop hooks, white boards, as well as all items mentioned in the above referenced spec sections.

17. Equipment items designated as Owner-Furnished/Contractor-Installed are a part of this scope of work. Owner furnished equipment isolated to an electrical connection "only" will be handled by the electrical subcontractor. Equipment requiring water, steam, medical gas, ducting, etc. will be handled by the mechanical subcontractor. All equipment that does not have any mechanical and/or electrical connection is the responsibility of this work category to receive, unload, distribute, and install.

18. All required temporary enclosures, materials, shoring, etc., to perform the demolition of the existing wall systems. Temporary enclosures must be weather tight.

19. Protect from damage existing finish work that is to remain.

20. Furnish and install sealants for all materials installed by this contractor such as cabinets, counters, sills, etc.

21. Furnish shop drawings, samples, product data, test reports, coordination drawings and other submittals as specified. Coordinate submittal schedule with the Construction Manager.

Specific Notes and Details:

The following details and notes are included in this Work Category; this list is to clarify the specific items noted below and does not exclude other details or otherwise limit the scope of work for this Work Category.

1. This work category responsible for all concrete related work. This includes but not limited to concrete demo, prep work, mesh, fill, vapor barrier, dowels, concrete, and equipment pads. All earthwork needed for concrete work by this work category.

2. This work category responsible for all masonry related work. This includes but not limited to masonry demo, lintel demo, patching, toothing, grout fill, air/weather barrier, termination bar, weeps, and new install. Patch existing masonry where items are demoed and called out to be patched including but not limited to thermostats, tack strips, tack boards signage, PEG hooks, etc..

   A. Sawcut and remove exterior wall for new openings as required for new mechanical work. Provide and install plywood at all exterior openings created by this work category for weather and security protection.

   B. Include shoring as needed for masonry work.

   C. Salvage existing masonry to re-use as much as possible.

   D. Include providing and installing angles and lintels.

3. Perform all architectural demo including but not limited to masonry, doors, hardware, concrete, casework, wall base, tack strips, glass blocks, siding, gypsum board, and plaster. Protect all existing materials, equipment, furnishings, etc. including but not limited to taping perimeter of all doors to rooms that will not be used (storage rooms off of classrooms for example).

   A. Remove, salvage and re-install exterior signage per keynote D6 on Averill architectural demolition drawings.

   B. Modify existing storage shelving as noted in keynote D13 on Averill architectural demolition drawings.

   C. Remove and salvage existing wall mounted PEG hooks.

4. This work category responsible for flooring patching. The extent of flooring patching is not defined so this will be funded from your allowance. This work category to provide labor rates for flooring work.
5. Prep existing doors and frames that are called out to receive new hardware.
6. Furnish and install plywood sills at louver openings.
7. Provide and install casework, countertops and shelving at side of unit ventilators. Rework/modify existing casework, countertops, end panels, etc. as needed. Metal filler panels by WC 27.
8. Provide temporary fire extinguishers (during construction) within a freestanding wood cabinet painted in red, labeled "fire extinguisher" as located by the Construction Manager. Removal following use included. Quantity for each area to match minimum required by MIOSHA.
9. Protect existing window frames during lintel and masonry demolition and installation similar to detail 2/A-002 for Lyons.
10. Remove, salvage, and re-install wood trim at clearstory work at Lyons. Provide and install blocking, siding, and associated accessories at clearstory work at Lyons.
11. Removing, salvaging, and re-installing existing wall mounted equipment that will conflict with new mechanical work per notes D12 and A12 at Lyons to be performed by this work category but funded from your allowance.

Related Work by Others:

1. Dumpsters
2. Temporary water and electrical
3. Independent testing and inspections by Owner.
4. Roof mechanical equipment curbs and associated blocking by WC 27.
5. Roof accessories furnished and installed by WC 27.
6. Structural framing for roof mounted mechanical equipment at Lyons by WC 27.
7. Ceiling demo and patching by WC 21.

Allowances:

This Contractor shall include in their Base Bid a Construction Manager's allowance of $15,000. Reference Section 01020 for specific instructions on allowances. Intent of allowance is for flooring patching needed and removing/salvaging/re-installation existing wall mounted equipment related to notes D12 and A12 at Lyons.

Unit Prices:

Unit Prices are to be complete furnished in-place operations, and include all costs, incidental materials and work, insurance, fringes, bonds, engineering, overhead and profit. Reference the Trade Contract Proposal form for unit pricing required.

End of Work Category No. 20

Work Category No. 21 – Walls & Ceilings

Work Included:

The subcontractor shall timely perform all Walls & Ceilings work, as detailed below, in accordance with the contract documents (including Bidding Requirements, Proposal Section, Contract Forms, General Conditions, Supplemental Conditions, General Requirements, Addenda, etc.), including, but not limited to, the following Specification Sections and Work Scope Items. Unless otherwise noted, this contractor is responsible for all items specified in the following specifications sections:

Reference W.C. Index and Cross Reference

Work Category Notes:

1. Furnish and install all interior and exterior gypsum board, metal stud framing, cold-formed framing, insulation, ceiling grid, ceiling tile, as shown and/or specified. Includes all labor, material, accessories, and equipment for a complete installation.
2. Above ceiling support wires for ceiling grid, soffits and hard ceilings will be installed after MEP-above ceiling rough-ins. Hanger wires where required to support light fixtures, grilles, and registers, etc.
3. All interior and exterior wall and ceiling fire stopping, thermal and acoustical insulation as it relates to this contractors work.
4. Acoustic sealants and caulking of work within this work category including bottom, sides and top of rated walls. Furnish and install all necessary fire caulking related to this W.C including all required fire taping of walls and ceilings. Subcontractor shall be required to fire-stop, smoke seal and sound seal, all other remaining penetrations, and schedule all Work of this type to completed and inspected just prior to ceiling grid installation.
5. Properly fire stop and seal all fire wall penetrations created by this work. Fire stop to mechanical, electrical, and plumbing sleeves furnished and installed by others.
6. Furnish and install all access panels shown on the drawings in stud partitions or ceilings including mechanical and electrical panels. It is your responsibility to review all drawings complete including the mechanical and electrical drawings. Install all access panels in metal stud walls and ceilings furnished by mechanical, fire protection, and electrical contractors (not shown on drawings).
7. Furnish and install all ceiling surfaces per the drawings and specifications.
8. Extreme care is to be taken when installing hangers and equipment in the area that has "spray on fireproofing", so as not to damage it. This contractor will be responsible for patching fireproofing in case of damage by this trade.
9. Install all light gauge metal framing including truss system & stiff clips.
10. Tape and sand joints to bottom of gypsum board to provide even, clean joints to receive vinyl base.
11. All cold-formed framing, fire-stopping, vapor barriers, non-load bearing steel framing, gypsum board, glass-reinforced gypsum fabrications, acoustical ceilings, acoustical wall panels Work, including all labor, materials and equipment required for a complete installation.
12. All interior joint sealants at the following conditions:
    a. Hollow metal door & window frame-to-gypsum board

b. Gyp. Board-to-curtain wall aluminum framing

Note: Joint sealants at millwork and solid surface window sills, by others (WC-20).

Specific Notes and Details:

The following details and notes are included in this Work Category; this list is to clarify the specific items noted below and does not exclude other details or otherwise limit the scope of work for this Work Category.

1. Remove, salvage, and reinstall ceilings as needed for overhead MEP work. Take detailed existing photos and videos of existing ceiling system before and after removal. Provide any new ceiling tiles and grid that get damaged as a result of construction (will be charged to contractor who damaged ceiling tiles/grid).
2. Patch existing plaster walls where masonry and lintels are removed at unit ventilators.
3. Rework ceiling grid and tiles around vertical unit ventilators.

Related Work by Others:

1. Dumpsters by Construction Manager.
2. Temporary Water and electrical by Construction Manager.
3. Independent testing and inspections by Owner.

Allowances:

This Contractor shall include in their Base Bid a Construction Manager's allowance of $0. Reference Section 01020 for specific instructions on allowances.

Unit Prices:

Unit Prices are to be complete furnished in-place operations, and include all costs, incidental materials and work, insurance, fringes, bonds, engineering, overhead and profit. Reference the Trade Contract Proposal form for unit pricing required.

End of Work Category No. 21

Work Category No. 24 – Painting & Wallcovering

Work Included:

The subcontractor shall timely perform all Painting and Wallcovering work as detailed below, in accordance with the contract documents (including Bidding Requirements, Proposal Section, Contract Forms, General Conditions, Supplemental Conditions, General Requirements, Addenda, etc.), including, but not limited to, the following Specification Sections and Work Scope Items. Unless otherwise noted, this contractor is responsible for all items specified in the following specifications sections:

Reference W.C. Index and Cross Reference

Work Category Notes:

1. Furnish all labor and material to complete all interior and exterior painting and wall coverings as shown and/or specified, including but not limited to; exposed masonry, exposed steel, exposed unfinished wood materials, field painting of equipment, concrete walls, lintels, door frames, louvers, mechanical, and electrical piping, etc. including all labor, materials and equipment required for a complete installation.
2. All required surface prep for this work including touch up of steel primer as required.
3. Final wall preparation to include minor patching (scratches and small dents) and minor caulking in all areas which call out for paint. All areas should be reviewed by the painter prior to new finishes being applied.
4. Finishing of millwork/casework and trim items not furnished pre-finished, including wood filler, and putty if required. Light sanding may be necessary prior to applying finishes.
5. Temporary protection of all areas and clean up of paint overspray (if materials are outside of interior renovations) and drippings. Protect all new and existing finishes adjacent to painted areas prior to painting.
6. Protect fire suppression heads; promptly remove protection.
7. Sequence the work as follows: patching and priming, first finish coat, installation of cabinets, tops, etc, and then final coat. Multiple mobilizations will be required by this work category due to phasing of construction.

Specific Notes and Details:

The following details and notes are included in this Work Category; this list is to clarify the specific items noted below and does not exclude other details or otherwise limit the scope of work for this Work Category.

1. Include misc. prep and painting where old devices, etc. are called out to be demoed.

Related Work by Others:

1. Caulking of masonry joints by WC 20.

Allowances:

This Contractor shall include in their Base Bid a Construction Manager's allowance of $5,000. Reference Section 01020 for specific instructions on allowances.

Unit Prices:

Unit Prices are to be complete furnished in-place operations, and include all costs, incidental materials and work, insurance, fringes, bonds, engineering, overhead and profit. Reference the Trade Contract Proposal form for unit pricing required.

End of Work Category No. 24

Work Category No. 27 – Mechanical and Plumbing Systems

Work Included:

The subcontractor shall timely perform all Mechanical and Plumbing work, as detailed below, in accordance with the contract documents (including Bidding Requirements, Contract Forms and General Conditions, Supplemental Conditions, General Requirements, Addenda, etc.), including, but not limited to, the following Specification Sections and Work Scope Items. Unless otherwise noted, this contractor is responsible for all items specified in the following specifications sections:

Reference W.C. Index and Cross Reference

Work Category Notes:

1. Furnish and install all mechanical and plumbing systems, including domestic water, sanitary and vent, compressed air, water for injection systems, hydronic piping, unit heaters, air handling units, mechanical louvers, radiant heat systems, humidifiers, condensate, heat exchangers, ductwork, insulation, plumbing fixtures, temperature controls including DDC or BMS systems, system commissioning, air and water balancing, etc., indicated by the contract documents (not just limited to the mechanical and plumbing drawings) or as required for a complete installation, including labor, materials, accessories and equipment for a complete installation.
2. Investigate areas prior to demolition activities, reroute and relocate existing services required for occupied operation. Cut, cap, and make safe, all existing plumbing, medical gases, temperature controls and HVAC systems in renovated areas prior to demolition. Properly identify and mark system and components to be removed.
3. All cutting, capping, coring, patching and firesafing of walls, floors, ceilings, etc., required for the installation of this work. Patch and repair work is to be done professionally by skilled craftsmen. All such openings require prior written approval from the Construction Manager, before work begins. Furnish and install all sleeves and or misc. steel in walls, floors, roofs and ceilings that may be required by this W.C.
4. All utility connection, disconnections, tie-ins, crossovers, shut downs and similar work must be performed and scheduled so they will not interfere with other work. It may be necessary to make these changes during "off" hours, or it may be necessary to make "hot tap" connections. The contractor should plan on premium time for this work. Coordinate with the Construction Manager prior to performing this work.
5. Furnish access panels where required for the wall and ceiling valves, dampers and controls that are not shown on the Architectural/Mechanical plans but are necessary for the Mechanical Systems.
6. Extreme care is to be taken when installing hangers and equipment in the area that has "spray on fireproofing", so as not to damage it. This contractor will be responsible for patching fireproofing incase of damage by this trade. This work is to be performed by a qualified contractor so that the warranty will not be affected.
7. Furnish all hoisting, lifting, scaffolding and handling of all materials required to complete this work category.
8. The Electrical and Mechanical Contractors will be required to coordinate in a formal coordination process to accomplish the rough-in and final layout as required and specified in Section 1049. Any relocation required to coordinate work will be done at no additional cost to the Owner. All contractors are required to furnish layout and coordination prints for their work prior to these meetings allowing the team to be better prepared at each coordination meeting. Detailers will be provided by this contractor to accomplish this coordination. These meetings shall be coordinated with the construction manager and shall be held

on-site.

9. Provide and install mechanical equipment tags, pipe identification and other required identification of signage related to his work.

10. Furnish and install all roof curbs and necessary or required auxiliary steel framing for equipment supplied under this W.C. This includes any auxiliary steel required at roof openings not shown on the structural drawings, or for pipe hangers and plenum stiffeners.

11. A coordination meeting will be set up between the controls contractor, mechanical contractor, electrician, and construction manager prior to control work. This will include all required work for a complete system as indicated in the construction documents.

Specific Notes and Details:

The following details and notes are included in this Work Category; this list is to clarify the specific items noted below and does not exclude other details or otherwise limit the scope of work for this work category:

1. This work category responsible for all plumbing and mechanical demolition including but not limited to unit ventilators, piping, louvers, fintube, thermostat and associated accessories.

2. This work category responsible for cutting pipes flush with floor and filling with non-shrink grout similar to keynote D5 on architectural demo drawings at Averill and MD1 on MD100 at Lyons.

3. Provide and install metal filler panels and tops to match adjacent casework for a complete installation including all accessories at Averill.

4. Receive, unload, and install Vertical Unit Ventilators, Horizontal Unit Ventilators, Condensing Units and associated accessories. Trane has purchased these already and will deliver them to site at the beginning of the project.

5. Responsible for controls, commissioning, & testing and balancing.

6. WC 21 will selectively remove and re-install ceiling grid as needed for MEP overhead installation. This work category will be working around existing ceiling grid/tiles and needs to take precautions not to damage them.

7. This work category responsible for all roof work including but not limited to roof demo, deck demo, shoring of roof if needed, and roof patching. Bornor Restoration, Inc. has the warranty on the roof at Lyons Elementary. All work must be done to keep warranties in tack.

    a. Responsible for all work related to roof curb details for new roof mounted mechanical equipment. This includes but not limited to curbs, structural steel, insulation, roof patching, blocking, and caulking for a complete installation.

    b. Provide, install, maintain, and remove flagging per MIOSHA standards at Lyons for all contractors use.

    c. Provide and install walkway protection boards under each pipe support similar as called out on typical roof gas piping support detail on M-501 for Lyons.

8. Provide and install break/sheet metal enclosures for piping and mechanical equipment similar to detail 2/A-401 at Lyons and notes M03.

9. Include labor and equipment as required for all confined space entry monitoring and rescue, for work performed within this work category.

Related Work by Others:

1. Power supply to mechanical equipment by W.C. 28.
2. Installation of access panels/doors by W.C. 21.
3. Counter tops to be cut by WC 20.

Allowances:

This Contractor shall include in their Base Bid a Construction Manager's allowance of $0. Reference Section 01020 for specific instructions on allowances.

Unit Prices:

Unit Prices are to be complete furnished in-place operations, and include all costs, incidental materials and work, insurance, fringes, bonds, engineering, overhead and profit. Reference the Trade Contract Proposal form for unit pricing required.

End of Work Category No. 27

Work Category No. 28 – Electrical Systems

Work Included:

The subcontractor shall timely perform all Electrical work, as detailed below, in accordance with the contract documents (including Bidding Requirements, Contract Forms and General Conditions, Supplemental Conditions, General Requirements, Addenda, etc.), including, but not limited to, the following Specification Sections and Work Scope Items. Unless otherwise noted, this contractor is responsible for all items specified in the following specifications sections:

Reference W.C. Index and Cross Reference

Work Category Notes:

1. Furnish and install all electrical systems, including power, lighting, fire alarm, telephone/data and CATV systems, system commissioning, etc., indicated by the contract documents (not just limited to the electrical drawings) or as required for a complete installation, including labor, materials, equipment, adhesives, fasteners, supports, hangers, grounds, blocking, shims and all necessary anchoring devices and accessories.
2. Investigate areas prior to demolition activities, reroute and relocate existing services required for occupied operation. Cut, cap, and make safe, all existing electrical systems in renovated areas prior to demolition. Properly identify and mark system and components to be removed by others.
3. All cutting, capping, coring, patching and firesafing of walls, floors, ceilings, etc., required for the installation of this work. Patch and repair work is to be done professionally by skilled craftsmen. All such openings require prior written approval from the Construction Manager, before work begins. Furnish and install all sleeves and or misc. steel in walls, floors, roofs and ceilings that may be required by this W.C.
4. Furnish drawings showing size and location of concrete pads indicated on the drawings for electrical equipment to the Construction Manager. Installation of these pads is by W.C. 20. All excavation, backfill and compaction related to this W.C. Suitable backfill will be required by this trade and this contractor will be responsible for removal (from site) of all unsatisfactory fill in accordance with the documents.
5. All utility connection, disconnections, tie-ins, crossovers, shut downs and similar work must be performed and scheduled so they will not interfere with other work. It may be necessary to make these changes during "off" hours, or it may be necessary to make "hot tap" connections. The contractor should plan on premium time for this work. Coordinate with the Construction Manager prior to performing this work.
6. Furnish access panels where required for the wall and ceiling valves, dampers and controls that are not shown on the Architectural/Electrical plans but are necessary for the Electrical Systems.
7. Extreme care is to be taken when installing hangers and equipment in the area that has "spray on fireproofing", so as not to damage it. This contractor will be responsible for patching fireproofing incase of damage by this trade. This work is to be performed by a qualified contractor so that the warranty will not be affected.
8. Furnish all hoisting, lifting, scaffolding and handling of all materials required to complete this work category.
9. The Electrical and Mechanical Contractors will be required to coordinate in a formal coordination process to accomplish the rough-in and final layout as required and specified in Section 1049. Any relocation required to coordinate work will be done at no additional cost to the Owner. All contractors are required to furnish layout and coordination prints for their work prior to these meetings allowing the team to be better prepared at each coordination meeting. Detailers will be provided by this contractor to accomplish

this coordination. These meetings shall be coordinated with the construction manager and shall be held on-site.

10. Provide and install panel labeling, identification and other required identification of signage related to his work.

11. A coordination meeting will be set up between the controls contractor, mechanical contractor, electrical contractor, and construction manager prior to control work. This will include all required work for a complete system as indicated in the construction documents.

12. Electrical connections to equipment and devices provided by others, including by not limited to duct detectors, fire dampers, flow and tamper switches, variable frequency drives, Owner furnished items, etc. Verify construction documents have been coordinated with power requirements of equipment prior to installation of devices.

13. Furnish and install electrical disconnects for all mechanical equipment provided by W.C. 27.

Specific Notes and Details:

The following details and notes are included in this Work Category; this list is to clarify the specific items noted below and does not exclude other details or otherwise limit the scope of work for this work category:

1. Responsible for all electrical demolition.

2. Receive and install transformers, switchboards, and panelboards which have been previously purchased by Superior Electric of Lansing, Inc..

3. Install occupancy sensors. Work with controls contractor to tie them into unit ventilator controls.

4. All excavation and backfill related to Work including suitable backfill, compaction, & restoration and removal (from site) of all unsatisfactory fill in accordance with the documents.

5. This work category responsible for making the conduit above grade in mechanical/electrical ME1A room meet codes per NEC 230.6. If concrete encased is chosen, this work category responsible for that concrete work.

6. Perform 30-day load study as called out in the contract documents.

Related Work by Others:

1. Concrete equipment pads by WC 20.

2. Installation of access panels/doors by WC 21.

3. Low voltage wiring not identified on the drawings by the trade providing equipment.

4. Site utilities to transformers/cabinets by Utility Company.

5. Temperature Control wiring and conduit associated with the mechanical systems by WC 27.

Allowances:

This Contractor shall include in their Base Bid a Construction Manager's allowance of $5,000. Reference Section 01020 for specific instructions on allowances. Intent of the allowance is to support cabling that rests on the ceiling grid when it is removed and re-installed.

Unit Prices:

Unit Prices are to be complete furnished in-place operations, and include all costs, incidental materials and work,

insurance, fringes, bonds, engineering, overhead and profit. Reference the Trade Contract Proposal form for unit pricing required.

End of Work Category No. 28

Trade Contract Proposal
Pre-Submission Checklist

Trade Contract Proposal Form completely filled out?

Form signed by authorized officer of firm?

Costs for Performance and Labor & Material Bond excluded in base bid proposal sum but amount included in break out?

All taxes included in base proposal sum?

Bid security (bond or certified check or money order) of at least 5% of base proposal sum included?

Requested alternates & unit prices quoted?

Sworn & Notarized Familial Affidavit for Lansing School District included with your proposal?

Sworn & Notarized Familial Affidavit for C2AE and Christman included with your proposal?

Non-Discrimination Certification included in your proposal?

Affidavit of Bidder – Non-Collusion included with your proposal?

Iran Sanctions Certificate and Act Certificate included in your proposal?

Legal Status of Bidder Certificate included in your proposal?

All information (proposal, bond, etc.) Submitted in duplicate?

Proposal submitted in sealed envelope per specifications?

TRADE CONTRACT PROPOSAL FORM

WORK CATEGORY NO. 00 and _____ Date: _____

TO: The Christman Company
208 N. Capitol Avenue
Lansing, MI 48933-1357

Re: AC Installation Package - Averill & Lyons Elementary Schools

Gentlemen:

Having carefully examined General Conditions, Supplementary Conditions, General Requirements, Advertisement for Bids, Instructions to Bidders, Proposal Section, Specifications, Drawings, all Addenda issued, Work Category Descriptions, and understanding the scope of work involved in this Work Category (ies) and those that interface with it (them), the undersigned does hereby propose to furnish all labor, materials, insurances, taxes, tools, equipment and services to complete all work required for the Work Category(ies) indicated in accordance with the Work Category Description and the Contract Documents prepared by _____.

BASE PROPOSAL SUM:

_____
_____ ($_____)

PERFORMANCE & PAYMENT BOND: The Trade Contractor may be required to furnish a Co-Obligee Labor & Material Payment & Performance Bonds for the full contract amount.
The name of the Bonding Company is: _____.
The sum of ($_____) to cover cost of furnishing these bonds is ***added to*** the base bid.

EXPERIENCE MODIFICATION RATING (EMR):
List the EMR for your firm as determined by your insurance carrier for the past three (3) years.
2022 _____ 2021 _____ 2020 _____

ADDENDA: The following Addenda have been received, are hereby acknowledged, and their execution is included in Bid Sums listed herein.
No _____ Dated _____ No _____ Dated _____ No. _____ Dated _____

TIME AND MATERIAL RATES: Replace with itemized form to be submitted at bid? Including sub-tier subcontractors

Labor rates listed below include the following:

Cost of labor including Michigan Single Business Tax, Social Security and Medicare, Federal and State Unemployment Tax, and Fringe Benefits Under Collective Bargaining Agreements, and Worker's Compensation Insurance. The rates listed below do not include overhead and/or profit. These rates are only for additions and/or deletions to the contract that could not have been anticipated at the time of the bid.

TRADE CONTRACT PROPOSAL FORM

WORK CATEGORY NO. 00 and _____ Date: _____

	TRADE	STRAIGHT TIME	SHIFT TIME	1 1/2 TIME	DOUBLE TIME
1					
2					
3					
4					
5					
6					

OVERHEAD AND PROFIT(FOR FUTURE CHANGES): Overhead and Profit shall include the following: Supervision, Superintendents, Commercial General Liability and Umbrella Insurances, Wage of Time Keepers, Watchmen and Clerks, Small tools with material value of less than $1,500.00. Incidentals, General Office Expense, and all other expenses not included in Labor Rates as listed above. The percentage fee for Overhead and Profit on the Contractor's own work shall be 15% of net cost. The percentage fee for Overhead and Profit on Subcontractor's work shall be 5% (see log).

MANDATORY ALTERNATES:
Reference Specification Section 01100 for alternate descriptions.

Alternate #1 – Lyons – Work Associated with Storage Room 114S Add/Deduct $_____

UNIT PRICES:
None

VOLUNTARY ALTERNATIVES (Variations From Materials Specified):
Undersigned proposes the following voluntary alternates for materials and/or equipment specified, it being understood that, should any voluntary alternate(s) be accepted by the Owner, applicable amount(s) hereinafter listed will be added to or deducted from the Base Bid. (No voluntary alternates are required)

1. _____ $ _____ (Add/Deduct)
2. _____ $ _____ (Add/Deduct)
3. _____ $ _____ (Add/Deduct)

SCHEDULE:
The undersigned if awarded a Contract, agrees to work concurrently with the work of other Trade Contractors and the Construction Manager, according to the "Approved Construction Schedule."

BIDDER'S CERTIFICATE:

I hereby certify that all statements herein are made on behalf of

_____
Bidder's Name

TRADE CONTRACT PROPOSAL FORM

WORK CATEGORY NO. 00 and _____ Date: _____

_____
(Name of Corporation, Partnership or Person Submitting a Bid)

A Corporation organized and existing under the laws of the State of _____

An individual doing business as _____

Signature:
Title:
Address:

Phone:
Fax:
Email:

CHRISTMAN
SINCE 1894

Job No. **Work Category:**

** SUBCONTRACT **

This Subcontract (Agreement) is dated , between , , with its principal place of business at 208 N. Capitol Avenue, Lansing, MI 48933-1357 (Christman), and , with its principal place of business at , (Subcontractor). Christman and Subcontractor are collectively called the Parties. The Parties agree:

ARTICLE 1 - PROJECT

Subcontractor shall perform and pay for all of the Work, for the Contract Sum on the following Project known as , located at , , , , for (Owner) in accordance with the documents prepared by (Architect/Engineer).

ARTICLE 2 - CONTRACT SUM

2.1 Contract Sum Subcontractor shall perform the Work for the Contract Sum, subject to adjustment only with Christman's prior written approval for changes in the Work. For the complete, timely, and satisfactory performance of the Work, Christman will pay Subcontractor the Contract Sum, subject to additions or deletions by Change Order, and subject to the terms of the Contract Documents. The Contract Sum shall not be adjusted unless Subcontractor shall have strictly complied with Articles 13 (Changes). Notwithstanding the foregoing, Christman may adjust the Contract Sum by Change Order, without Subcontractor's consent, for backcharges, set offs, or all costs associated with Subcontractor's Default. Subcontractor shall pay for all costs to perform its obligations, even if those costs exceed the Contract Sum.

Sample

Contract Sum: * DOLLARS*****

. Work Category

Total for Subcontract:

2.2 Resource Planning The Contract Sum shall include any material or labor escalation, incidental costs required for the Project, any additional crews, overtime, shift time, and any other resource necessary to meet the Project Schedule, including any revisions or amendments to the Schedule.

2.3 Employer Contributions & Taxes The Contract Sum shall include: (a) all wages, prevailing wages (if required), premiums, payroll taxes, pension, fringe, welfare, vacation, annuity, travel pay, and union or benefit contributions, apprenticeship or industry advancement funds payable in connection with the Work if applicable or as required by Applicable Laws (collectively, Employer Contributions); and (b) all taxes arising out of Subcontractor's furnishing or installing any labor, material and equipment including but not limited to sales, use, personal property, and excise taxes (collectively, Taxes). Before receiving final payment, Subcontractor shall certify that it has paid all Employer Contributions and Taxes.

2.4 Patents & Copyrights The Contract Sum shall include all license fees and royalties for all items, materials, methods, or systems for the Work provided by subcontractor.

2.5 Lump Sum This is a lump sum contract. Subcontractor represents and warrants that it has independently investigated and ascertained the quantity and cost of the Work. The Contract Sum shall not be adjusted for increases in the quantity or cost of labor or materials. Subcontractor assumes exclusive liability for all matters required to be included in the Contract Sum.

ARTICLE 3 - WORK

3.1 The Work Subcontractor shall provide and install all labor, materials, tools, equipment, hoisting, scaffolding, insurance, Taxes, supervision, services, design, and all other items, in the quantities necessary to properly, efficiently and timely prosecute and

complete the Work identified in the Contract Documents and Supplements, except to the extent specifically indicated in the Contract Documents to be the responsibility of another trade (the Work). The Drawings and Specifications describe the general scope of the Project, and as such, they do not necessarily describe all work required for the full performance of the Work. The Parties execute this Agreement on the basis of such documents with the understanding that Subcontractor shall furnish and install all items reasonably implied or inferable by Christman or the Owner from the Contract Documents as required for the proper completion of the Work without adjustment to the Contract Sum. Subcontractor shall perform the Work in strict accordance with the Contract Documents. All workmanship shall be of the highest grade. All materials and equipment shall be new except as provided in the Contract Documents.

ARTICLE 4 - CONTRACT DOCUMENTS

4.1 Contract Documents Subcontractor, and its subcontractors, consultants, laborers and suppliers (collectively, Lower Tiers), shall be bound by the Contract Documents which consist of this Agreement, Exhibits to this Agreement, the agreement between Christman and Owner/Customer (Prime Contract) except as otherwise provided in this Agreement, all documents incorporated in the Prime Contract, the Drawings, Specifications, Addenda, Conditions, and any documents set forth in Supplements, all of which are incorporated herein and made a part of this Agreement, except payment terms of the Prime Contract and except dispute resolution terms of the Prime Contract as they relate to the specific method of final dispute resolution after claim submission, in which case Article 16 (Dispute Resolution) controls. Subcontractor shall perform all Work subject to all terms and conditions, express or implied, in the Contract Documents relating to its Work, it being the intention that Subcontractor will fully, properly and faithfully discharge the obligations of Christman insofar as the Subcontractor's Work.

4.2 Flow Down Subcontractor assumes toward Christman all of the obligations and responsibilities that Christman, by the Contract Documents, assumes toward Owner insofar as the Subcontractor's Work, regardless of whether Owner enforces these obligations against Christman. Subcontractor shall not have any right or remedy against Christman which Christman does not have to or against the Owner under the Contract Documents. Subcontractor shall incorporate the Contract Documents by reference into any agreements with Lower Tiers. By written contract, Subcontractor shall require its Lower Tiers to assume towards Subcontractor and Christman all of the obligations including but not limited to, insurance, indemnity, and defense that Subcontractor, by the Contract Documents, assumes toward Christman insofar as the Subcontractor's Work. If requested by Subcontractor, Christman shall supply Subcontractor with a copy of the Prime Contract with confidential information redacted.

Sample

4.3 Conflicts & Interpretation The Contract Documents are intended to complement each other and shall be so interpreted where possible. If, however, any provision of this Agreement irreconcilably conflicts with another provision of the Contract Documents, the provision imposing the greater duty, greater quality, or more stringent requirement on Subcontractor shall govern. Further, to the extent the Contract Documents give the Architect/Engineer or Owner the right to determine quantities, quality, and other factors relating to the Work, such determinations shall be binding on Subcontractor to the same extent they are binding on Christman.

4.4 Acceptance Subcontractor's signature on this Agreement or the start of any Work shall constitute Subcontractor's acceptance of this Agreement. However, this Agreement is expressly contingent upon Owner approving Subcontractor. Upon Christman's notice to Subcontractor that Owner rejects Subcontractor, Subcontractor shall have 5 days after notice to overcome its disqualification to the satisfaction of Owner, otherwise this Agreement shall be deemed null and void.

ARTICLE 5 - BONDS

5.1 Surety Qualification If Performance and/or Payment bonds are required, Subcontractor shall pay for and deliver such bonds, within 10 days of Christman's request using the form specified by Christman and attached to this Agreement, each in the full amount of this Agreement, issued by a United States (U.S.) Treasury listed surety with an AM Best rating of A or better, approved and licensed to do business in the state where the Project is located (Controlling State), duly executed by agents with complete Power of Attorney to the full limits therein. Christman shall have the right, in its discretion, to reject Subcontractor's bonds and surety and to require replacement of the bonds and/or surety, at Subcontractor's cost, if the surety proposed by Subcontractor does not meet any requirements of this Agreement upon submission. Subcontractor is not permitted any mark up on bond costs and shall present an invoice from its surety to establish the actual cost of any bonds. Subcontractor shall refund to Christman any rebate or refund in bond premiums resulting from adjustment in bonds.

5.2 Changes & Terms Christman shall have the right, without notice to Subcontractor's surety, to order changes in the performance or time of performance of the Work and to modify this Agreement. No extension of time, change, addition, or omission of terms in this Agreement or the Prime Contract shall affect the surety's obligation on the bonds. Subcontractor and its surety waive notice to the surety of any such extension of time, change, addition, or omission. Subcontractor and surety agree without the necessity for any further authorization, to increase the bonds' penal sums if or when additive changes to the Contract Sum are executed. Christman's response to any surety inquiry as to Subcontractor's performance shall not estop or impair Christman's rights under this Agreement or any bond, and surety shall be required to conduct its own independent investigation of Subcontractor's performance.

5.3 Duration Any Performance Bond shall guaranty Subcontractor's performance through the end of any warranty period and any statute of limitation as to surety's obligations under the Performance Bond shall not begin to accrue until the warranty period ends, subject to the requirements of the Prime Contract and as allowable by Applicable Law.

ARTICLE 6 - INSURANCE

6.1 General Obligation Before starting any Work and as a condition precedent to payment, Subcontractor shall maintain insurance in the types, coverages, and for the limits as set forth below, in the Prime Contract, or in Subcontractor's actual policies of insurance, *whichever is greater or requires more*, and shall furnish Certificates of Insurance (COI) evidencing such insurance.

a. Worker's Compensation — Statutory Limit | $1,000,000 Employer's Liability

b. Commercial General Liability (CGL)*
   1) Bodily Injury — $2,000,000 Each Occurrence | $2,000,000 Per Project Aggregate
   2) Property Damage — $2,000,000 Each Occurrence | $2,000,000 Per Project Aggregate

   Subcontracts greater than $3,000,000
   1) Bodily Injury — $5,000,000 Each Occurrence | $5,000,000 Per Project Aggregate
   2) Property Damage — $5,000,000 Each Occurrence | $5,000,000 Per Project Aggregate

   *Coverage shall be occurrence based and shall include products and completed operations, contractual and independent contractors, and where applicable, underground hazard and/or explosion and collapse

c. Comprehensive Automobile Liability
   1) Bodily Injury — $2,000,000 Each Occurrence | $2,000,000 Per Project Aggregate
   2) Property Damage — $2,000,000 Each Occurrence

d. Professional Liability - when the Work includes any design, engineering, or professional services with a deductible and/or self-insured retention, including those relating to defense costs, not in excess of $25,000
   $2,000,000 Each Occurrence | $2,000,000 Per Project Aggregate

Insurance policy limits shall be in the amounts specified above, as required by the Prime Contract, or as specified in Subcontractor's policies, *whichever is greater*. Policy limits may be achieved through a combination of underlying and excess (umbrella) coverage. Unless the Prime Contract provides for insurance by and at the expense of Owner to protect Subcontractor against loss, Subcontractor shall provide for all of its own insurance of every kind.

6.2 Additional Insured Subcontractor shall name the Owner, Architect/Engineer, Christman, and their directors, officers and agents, and any other persons or entities listed in the Prime Contract and Supplements, as additional insureds (AI) on every policy of insurance, except Workers Compensation, including under the completed operations coverage, using AI ISO form Endorsements CG 20 10 07 04 and CG 20 37 07 04, and with respect to the Architect/Engineer, CG 20 32 07 04. All COIs shall include evidence of these endorsements. Insurance covering the AI parties shall be primary and all other insurance carried by any additional insured shall be excess.

Sample

6.3 Qualifications Subcontractor shall provide insurance from insurers with policy holder ratings not lower than "A" and financial ratings not lower than "XI" in the Best's Insurance Guide, latest edition in effect as of the date of the Agreement.

6.4 Duration Subcontractor warrants and represents that for the duration of its Work, and for such longer periods required herein, Subcontractor has and shall maintain the required insurance coverage. Subcontractor shall maintain Products and Completed Operations insurance for a minimum period of the longer of the following: (a) six years after the Project Substantial Completion Date; or (b) the period of the statute of limitation or the statute of repose of the Controlling State; or (c) the duration set forth in the Prime Contract.

6.5 Cancellation Subcontractor shall provide written notice to Christman of the cancellation or expiration of any required insurance within 3 days of the date of the cancellation or expiration or within 3 days Subcontractor is first aware of any notice of cancellation or expiration, whichever comes first. If Subcontractor becomes uninsured, such event shall be deemed a material breach of contract and an immediate Subcontractor Default without notice.

6.6 Subcontractor Property If any loss or damage to Subcontractor's own property occurs, Subcontractor shall look solely to its own insurance for recovery regardless of whether a Builder's Risk policy is in place on the project, and is solely responsible for its deductibles. Subcontractor shall hold harmless and defend Christman and Owner from such loss or damage.

6.7 Deductibles Subcontractor shall be solely and exclusively responsible for any insurance deductibles to the extent arising out of or relating in any way to its Work, including but not limited to claims which could be covered by Builder's Risk insurance.

6.8 Waiver of Subrogation Subcontractor unconditionally waives all of its rights and shall require its insurers and Lower Tiers to unconditionally waive all rights of subrogation against the Owner, Architect/Engineer, Christman, and their parent companies, affiliates, subsidiaries, partners, officers, directors, employees, and agents, and similarly waives all rights of subrogation against all other subcontractors, vendors and suppliers.

Sample

6.9 Vertical Exhaustion Subcontractor's underlying and excess coverage shall be primary and noncontributory to any policy of insurance maintained by any other entity and shall be vertically exhausted first in the order of coverage before any other policy of insurance. Subcontractor's excess policy shall be tied only to Subcontractor's underlying policy and shall not require the exhaustion of limits of policies of any insurance maintained by any other entity before attaching. Further, Subcontractor's excess policy shall not require the exhaustion of underlying limits only through the actual payment by the underlying insurer.

6.10 Lower Tiers Subcontractor shall require, and Subcontractor represents that its Lower Tiers will maintain, the insurance coverages specified in this Article including naming Owner, Architect/Engineer, and Christman, as additional insureds.

ARTICLE 7 - INDEMNITY

7.1 TO THE MAXIMUM EXTENT PERMITTED BY LAW, SUBCONTRACTOR SHALL INDEMNIFY, DEFEND AND HOLD HARMLESS OWNER, ARCHITECT/ENGINEER, CHRISTMAN, AND THEIR OFFICERS, DIRECTORS, EMPLOYEES, AGENTS AND ASSIGNS, AND OTHER ENTITIES IF ANY, THAT CHRISTMAN IS OBLIGATED TO INDEMNIFY BY THE PRIME CONTRACT, (COLLECTIVELY, INDEMNITEES) FROM AND AGAINST ANY AND ALL CLAIMS, ALLEGATIONS, DEMANDS, DAMAGES, COSTS, EXPENSES, PENALTIES, WORK STOPPAGE, ATTORNEY FEES, AND/OR LIABILITIES OF ANY TYPE OR KIND, REGARDLESS OF THE LEGAL THEORY, ARISING OUT OF OR RELATED TO THE WORK (COLLECTIVELY, CLAIMS) INCLUDING BUT NOT LIMITED TO ANY AND ALL CLAIMS: (a) personal injury or property damage or property impairment; (b) defects or omissions in Subcontractor's workmanship or materials provided; (c) Subcontractor's violation of any Applicable Law, regulatory violations, citations or penalties; (d) Subcontractor's breach or failure to perform this Agreement; (e) Subcontractor's use of Christman's equipment or equipment operator and Christman's use of Subcontractor's equipment in accordance with section 10.4; (f) Subcontractor's infringement of any patent, trademark or other proprietary right; (g) claims and/or liens per Article 12; (h) Subcontractor's breach of any representation or warranty; (i) damage to Subcontractor's own equipment and property; (j) Subcontractor's violation of any applicable confidentiality or nondisclosure agreement; (k) Subcontractor's failure to comply with all matters required to be included in the Contract Sum; (l) Subcontractor

substitutions, regardless of whether Christman or Owner consented to the substitution; and, (m) any claim as described in the Prime Contract. **THIS INDEMNITY OBLIGATION COVERS ALL CLAIMS CAUSED BY OR CONTRIBUTED TO, IN WHOLE OR IN PART, ANY ACTIVITY OR INACTIVITY OF SUBCONTRACTOR, ITS LOWER TIERS, AND THEIR OFFICERS, DIRECTORS, EMPLOYEES, OR AGENTS. THIS INDEMNITY APPLIES REGARDLESS OF ANY ACTIVE AND/OR PASSIVE NEGLIGENT ACT OR OMISSION OF INDEMNITEES. SUBCONTRACTOR, HOWEVER, SHALL NOT BE OBLIGATED TO INDEMNIFY AN INDEMNITEE FOR CLAIMS ARISING FROM THE SOLE NEGLIGENCE OF THAT SPECIFIC INDEMNITEE. THE INDEMNITY OBLIGATIONS SHALL NOT BE LIMITED IN ANY WAY BY ANY LIMITATION ON THE AMOUNT OR TYPE OF DAMAGES, COMPENSATION OR BENEFITS PAYABLE BY OR FOR SUBCONTRACTOR UNDER WORKER'S COMPENSATION ACTS, DISABILITY BENEFIT ACTS OR OTHER EMPLOYEE BENEFIT ACTS..**

7.2 Duty to Defend At its cost and with legal counsel reasonably acceptable to Christman, Subcontractor shall defend Indemnitees from any Claims, including those raised in an administrative hearing, arbitration or similar proceeding. The obligation to defend accrues immediately upon receipt of a notice of Claim. If Subcontractor fails to provide timely, competent defense, Christman shall be entitled to reasonable costs associated with assuming such defense, including but not limited to attorney fees and costs incurred to enforce this indemnity and defense provision.

7.3 Notice to Insurer/Surety Subcontractor shall advise its insurers and sureties of these indemnity, defense, and hold harmless and insurance obligations and shall obtain a contractual coverage endorsement to discharge its obligations as set forth herein.

7.4 Consideration The Parties agree that $1,000 of the Contract Sum is part of the consideration for this indemnity obligation. Only in those states where there must be a contractual limit on indemnity obligations, the contractual limit shall be three times the aggregate value of CGL insurance limits required by this Agreement.

Sample

7.5 Survival Subcontractor's indemnity and defense obligations shall survive the termination or expiration of this Agreement and the completion of the Work.

ARTICLE 8 - SAFETY

8.1 Responsibility Subcontractor represents that it has expertise in the particular means and methods required to safely execute the Work and that it maintains a consistently high level of safety and health compliance. At its expense, Subcontractor shall furnish its workers a place of employment free from recognized hazards that cause or are likely to cause serious physical harm. Subcontractor shall protect from injury, its employees engaged in the Work, employees of other trade contractors working adjacent to Subcontractors Work and all property and persons which may be affected by its operations. The prevention of accidents to workers engaged in the Work and others affected by the Work is the responsibility of Subcontractor. Subcontractor shall strictly comply with the Safety Program of Christman and the Owner, and all Applicable Laws. The Subcontractor shall submit to Christman, a current Safety Program and Experience Modification Rates for Subcontractor and Lower Tiers. Subcontractor shall employ all engineering controls, administrative actions, and personal protective equipment to eliminate, and where elimination is not possible, control and reduce worker exposure to hazardous conditions, including but not limited to respirable crystalline silica and asbestos containing material. Subcontractor shall periodically monitor and evaluate its engineering and work practice controls to ensure they are effective and to discover, prevent and detect hazardous conditions. Subcontractor shall furnish Christman copies of Safety Data Sheets for all materials to be used in executing the Work. Subcontractor's foreman/superintendent (Foreman), at a minimum shall have satisfactorily completed OSHA 10-Hour training. The Foreman shall be assigned for the duration of the Project so as to maintain continuity. The Foreman shall speak English and be able to translate into English for non-English speaking workers to facilitate communications and ensure mutual understanding. Subcontractor shall ensure that all non-English speaking workers fully understand the site safety requirements and their duties for safety, health, and welfare. Subcontractor shall immediately correct any unsafe or hazardous condition related to its Work. If Subcontractor fails to immediately correct an unsafe condition, Christman may have the unsafe condition corrected by others at Subcontractor's expense or direct that the Work be stopped in the area of the unsafe condition.

8.2 Hazardous Materials Christman makes no representation or warranty as to conditions described in any hazardous materials

survey. If Subcontractor encounters any hazardous conditions or materials, Subcontractor shall immediately stop Work in the affected area and notify Christman in writing. Subcontractor acknowledges that it is fully apprised of all Applicable Law regarding hazardous conditions or material and that it will be fully responsible for disturbing any hazardous material, including for any and all fines, penalties, or damages assessed against Subcontractor or Christman. If Subcontractor uses hazardous materials on site of any type for which an employer is required by Applicable Laws to notify its employees of such use Subcontractor shall, before using the materials on site, give timely written notice of the materials to Christman. Subcontractor shall immediately correct any unsafe or hazardous condition related to its Work. If Subcontractor fails to immediately correct an unsafe condition, Christman may have the unsafe condition corrected by others at Subcontractor's expense or direct that the Work be stopped in the area of the unsafe condition.

8.3 Notice Subcontractor shall immediately notify Christman and provide Christman with copies of all OSHA citations and accident reports.

8.4 Responsibility Per Article 7, Subcontractor shall bear sole responsibility for any Claims arising out of any breach of, in whole or in part, or failure to comply with this Article, by the Subcontractor or its Lower Tiers, their invitees, or vendors, including any claims arising from regulatory violations, citations or penalties.

ARTCLE 9 - DESIGN SERVICES (If Applicable)

9.1 Design Services If the Work includes any design, engineering or professional services, Subcontractor accepts the design standards, criteria and performance specifications in the Contract Documents and agrees that such data is sufficient for Subcontractor's proper design and functioning of the Work. Christman does not warrant the accuracy or completeness of information in the Contract Documents, however, Subcontractor may rely on these items to the same extent Christman is entitled to rely upon such items in the Prime Contract. Subcontractor agrees that its design services relate to a part of the overall design of the Project and that its design must integrate into the Project's overall design concept expressed, inferred or reasonably implied by the Contract Documents. Subcontractor shall coordinate its Work with the services performed by others. Subcontractor shall submit to Christman detailed drawings and specifications (Work Product) describing the requirements for the Work and showing the relationship of the Work to the overall Project. Subcontractor shall provide Work Product in the form and quantity required by the Contract Documents. Christman shall be entitled to rely upon the adequacy, accuracy and completeness of the services and certifications or approvals performed by Subcontractor and its Lower Tiers. Subcontractor shall perform agreed upon revisions and submit revised Work Product for Christman's review. Subcontractor shall provide written notice to Christman and other affected trades of all design development changes in sufficient time to preclude additional costs and conflicts with the work of others.

Sample

9.2 Design Consultant Subcontractor's engagement of any design consultant shall be subject to Christman's written approval. The consultant's seal shall appear on all drawings, calculations, specifications, certifications, shop drawings and other Work Product prepared by the consultant. All consultants shall be licensed in accordance with Applicable Laws and fully bound to Christman in the same manner as Subcontractor is bound to Christman for all Contract Document requirements applicable to the Work, including all insurance requirements, including professional liability insurance. Subcontractor shall be responsible for the services performed by its consultants.

9.3 Standard of Care Subcontractor's standard of care for all design services shall be the highest care and skill used by members of the design profession practicing under similar conditions at the same time and locality of the Project, or as stated in the Prime Contract, whichever imposes the higher standard of care.

ARTICLE 10 - EXECUTION OF THE WORK

10.1 Project Investigation Subcontractor assumes responsibility for all Project investigation as related to its Work. Subcontractor represents that it has carefully inspected the Project site. Subcontractor represents that it is familiar with, has satisfied itself as to, and assumes all risk of: (a) the nature, location, and amount of the Work; (b) site conditions and access; (c) ability to perform the Work in accordance with the Project Schedule and Contract Documents; (d) any Applicable Laws and inspection requirements; (e) all safety and barricade requirements; (f) the terms and conditions of applicable collective bargaining agreements, to the extent applicable; (g) the quality, quantity, and availability of labor, materials, equipment, and utilities; and, (h) the limiting physical, climatic, and other conditions. Subcontractor is not relying on any opinion or representation of Christman as to Project conditions.

Subcontractor shall be solely responsible for all cost, expense and damage that may result from Subcontractor's failure to perform or properly perform such investigations including its failure to properly notify Christman and obtain written approval before proceeding with related Work.

10.2 Document Investigation Subcontractor warrants that it has thoroughly reviewed and fully acquainted itself with the Contract Documents and that the Contract Documents are suitable and sufficient for their intended purposes, without any express or implied representation or warranty having been made as to their accuracy, consistency, adequacy, completeness or constructability. Subcontractor shall give written notice to Christman of any error, inconsistency, ambiguity or omission in the Contract Documents within the earlier of 3 days after Subcontractor first becomes aware of the error, or 3 days before the time Christman is required to make such claims to the Owner under the Prime Contract. Subcontractor shall not be excused from any provision of the Contract Documents due to a lack of knowledge or understanding of their content. Christman disclaims any and all warranties, express or implied, as to the accuracy or adequacy of the plans, specifications, design, or other Contract Documents. Subcontractor shall make no claim based upon such disclaimed warranties.

10.3 Qualifications Subcontractor represents and warrants at all times it shall obtain and maintain all necessary credentials, certifications, licenses and other qualifications to do business and safely perform the Work. Subcontractor's obligation to perform the Work is non-delegable and nontransferable. Subcontractor shall be solely responsible for determining, supervising and implementing the means, methods, techniques, sequences, procedures and inspections of its Work. Christman shall not be responsible for the direction, supervision, inspection, quantity or quality of Subcontractor's Work.

10.4 Progress & Cooperation Subcontractor shall furnish sufficient equipment, tools and materials and a sufficient number of properly skilled workers to carry on the Work and conduct its activities in a manner and at a rate of performance in all respects satisfactory to Christman and the Owner and in a manner that will not interfere with, disrupt or delay the activities of Christman, the Owner, or others involved in the Project. Subcontractor shall erect, maintain, inspect and operate all of its equipment including but not limited to scaffolding, hoists, and material handling equipment in accordance with Applicable Laws. Subcontractor shall not unreasonably refuse Christman's use of Subcontractor equipment. If Christman utilizes Subcontractor's equipment, Christman shall not be liable to Subcontractor for the erection, maintenance or inspection of any such equipment, except to the extent Christman has assumed such obligations under written agreement with Subcontractor, and any such use by Christman shall be done in strict accordance with equipment manufacturer's instructions. Any Christman employee engaged in such use has all the necessary and requisite training to operate such equipment. Subcontractor shall cooperate with Christman and others involved in the Project, including those that Subcontractor's schedule may affect, to avoid any conflict and to ensure a first class workmanlike job in every respect. Subcontractor shall maintain good order among its employees and others and not permit upon the Project any disorderly, intemperate, or unfit person or anyone unskilled in performing the Work. At all times Subcontractor shall have a competent person with authority available to act on its behalf. Subcontractor shall provide all technical personnel required to startup, test, commission, and operate any equipment, and to test and use any material, supplies, or other items provided by Subcontractor in connection with the Work and to instruct Christman and Owner's personnel in the operation and maintenance of any equipment, materials, supplies, or other items. Subcontractor shall not perform any work directly for Owner or any Owner tenant or deal directly with the Owner's representatives in connection with the Project.

Sample

10.5 Shop Inspection The Owner, Architect/Engineer, Christman, and their representatives, shall have full access at reasonable hours to Subcontractor's Work and its Lower Tier's shops, factories, or other places of business to inspect the general condition and progress of the Work.

10.6 Submittals Within the time directed by Christman and without delay, Subcontractor shall furnish all mock ups, submittals, shop drawings, product data, specifications, samples, interim design submissions if applicable, electronic data or similar items (Work Product). By submitting such Work Product, Subcontractor represents that it has verified materials, field measurements, and field construction criteria related thereto, or will do so, and has checked and coordinated the information in its Work Product with the requirements of the Contract Documents. If Subcontractor's Work Product is rejected after a reasonable number of reviews, Christman may backcharge Subcontractor for the actual costs to continue review and process the rejected Work Product. Subcontractor waives any claim arising out of Subcontractor's failure to comply with this requirement. Christman's review of Work Product shall be limited to conformance with general design and general detailing and Christman need not verify dimensions or field

conditions. Subcontractor shall not make any substitutions in the Work, unless it first requests in writing permission for a substitution by expressly identifying the item or method substituted, as a "Substitution" and then only upon receipt of Christman's written consent to such substitution. Christman or Owner's review or consent of any Work or Work Product, shall not relieve Subcontractor from its responsibility for any deficiency that may exist or from its obligation to perform the Work in strict accordance with the Contract Documents.

10.7 Layout Subcontractor shall be solely responsible for the layout, accuracy, and workmanship of its Work. Before starting its Work, Subcontractor shall examine the work of others affecting its Work and verify all dimensions set forth in the Contract Documents as they pertain to or may affect Subcontractor's Work. If any defect, conflict, or inconsistency exists, Subcontractor shall immediately notify Christman in writing. Subcontractor shall not proceed until the defect is corrected or Christman provides written authorization to proceed. If Subcontractor fails to inspect or give written notice, Subcontractor shall be deemed to have accepted the work of others as fit and proper to receive Subcontractor's Work and waives any claim as to the defects. Subcontractor is responsible for all corrective work.

10.8 Compliance Subcontractor shall obtain and pay for all necessary permits, licenses, assessments and inspections, and comply with all statutes, ordinances, rules, regulations and orders of any governmental or quasi-governmental authority applicable to the Work (Applicable Laws) including: any LEED building, sustainable construction means, methods or requirements, or energy performance requirements, including those in the Contract Documents; local, state or federal safety and health laws and regulations, including those related to hazardous materials, such as crystalline silica; local, state or federal fair employment practices laws, affirmative action programs, minority contracting programs, business ethics and compliance; rules and regulations of any Contract Compliance Division of the state and federal Civil Rights Commission or any similar commission having jurisdiction; all immigration laws, rules and regulations, including I-9 verification and E-verify; Buy American provisions; and, Davis Bacon and/or state prevailing wage requirements. At Christman's request, Subcontractor shall certify to Christman's satisfaction that its employees have presented the correct documents to legally work in the U.S. Subcontractor shall immediately correct any violations of Applicable Laws.

Sample

10.9 Protecting the Work Subcontractor shall protect all Work, tools, material and equipment against any loss, damage or theft (Loss). At its sole risk, Subcontractor shall bear any Loss to its Work arising from any cause until Substantial Completion as defined in the Prime Contract, or such duration required by the Prime Contract, whichever is greater. Subcontractor is responsible for any Loss to existing property, structures, materials or equipment, the Work, the work of others, and property of Owner and adjacent land owners, utilities, roads, bridges, and waterways, arising out of Subcontractor's operations. Subcontractor shall repair or replace such items to the satisfaction of and at no cost to Christman. If Subcontractor refuses or fails to repair, replace, or correct the Loss, at Christman's sole election, Subcontractor shall accept a deduction in Contract Sum to the extent of the cost incurred by Christman or demanded by Owner. If a dispute arises between Subcontractor and another trade as to which is responsible for any Loss, Christman may determine the responsibility for such Loss and its determination shall be final and binding upon Subcontractor. Christman may backcharge Subcontractor the reasonable actual costs to investigate and respond to such claims.

10.10 Christman Tools & Equipment Subcontractor is responsible for all unloading, moving, lifting, protection, securing, and handling of its materials and equipment at the job site. In consideration of Christman's permission to use any tools or equipment of any nature whatsoever, including but not limited to elevators, hoists, derricks, cranes, side tracks, and yards, Subcontractor contractually assumes complete risk, responsibility, and liability for the use or operation of such equipment, and for any Claim arising in any manner because of Subcontractor's use or operation of tools and equipment or use of same for Subcontractor's benefit, irrespective of who actually operated the tools and equipment.

10.11 Clean Up Subcontractor shall at all times keep the Project and Owner's premises, adjoining premises, and streets clear of rubbish, debris, overspray and similar items resulting from its Work and shall remove all such rubbish at its own expense, as directed by Christman. Subcontractor shall maintain broom clean conditions at the end of each day. Christman shall designate the location of all dumpsters. Subcontractor shall not dispose of any hazardous waste or waste requiring special manifests in these dumpsters. If Subcontractor fails to clean the site to the satisfaction of Christman and/or the Owner upon 24 hours' notice (except where such condition creates a safety concern, and in that case, without notice) then Christman may do so and backcharge Subcontractor the actual cost of cleanup.

10.12 Labor Relations Subcontractor shall only use labor which will not cause disharmony or labor disputes in the performance at the Project. Subcontractor shall implement policies and practices to avoid work stoppages, slowdowns, disputes, and strikes. Subcontractor shall notify Christman promptly of any actual or potential dispute that may affect the Work. Subcontractor guarantees that there shall be no strike, lock-out or other work slowdown affecting its Work or the work of others. Subcontractor represents that it has the legally binding agreement of all bargaining representatives of any part of its workforce (or before beginning Work will obtain such agreement), that the represented workers will not strike, picket, engage in any slow-down or other concerted activity where Work is performed, and will cross and work behind any picket line at the job site, regardless of by whom. If Subcontractor's workers are involved in a dispute with other trades on the Project, or any union, or such workers refuse work due to any labor disputes, Subcontractor shall immediately resolve the disputes. Failure to do so shall be a material breach of this Agreement. If a labor condition threatens the timely completion of any portion of the Work, Christman may, at its option, terminate Subcontractor's right to proceed with Work for Default or employ others to perform the affected Work and backcharge Subcontractor the cost thereof. Notwithstanding the foregoing, Subcontractor shall not be liable for strikes, work stoppages, jurisdictional disputes, lockouts, union and non-union disputes and other similar claims or conflicts ("Labor Issues") except to the extent such Labor Issues are caused, in whole or in part, by the actions or inactions of Subcontractor or anyone else for whom Subcontractor is responsible.

10.13 Meetings Subcontractor shall attend any project meetings as directed by Christman. Subcontractor shall be represented by its Project Manager or Senior Representative responsible for the Project and its Site Supervision. Subcontractor shall attend an on-site pre-installation meeting before beginning any Work. Christman will maintain and distribute to attendees minutes of the meetings for review. Subcontractor shall review the minutes and provide written notice of any objections within 3 days after issuance of the minutes; failure to do so shall be deemed Subcontractor's acceptance without reservation of the content of the minutes.

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10.14 Material Delivery & Installation Space for storage on the Project site may be limited. Subcontractor shall schedule material deliveries accounting for the limited storage or lay down area and to coincide with construction phasing. Subcontractor shall coordinate its access, deliveries, staging, trailers, storage areas and parking in advance, and as approved by Christman's superintendent before Subcontractor's mobilization on site. If Subcontractor's Work includes installation of materials or equipment furnished by others, Subcontractor shall examine the items with due care and install the items with such skill and care as to ensure a satisfactory and proper installation and to preserve all warranties. All material and equipment delivered to the job site or off site and in the process of fabrication shall become the property of the Owner and shall not be removed from the site or damaged in any way.

10.15 Cutting & Patching Unless otherwise directed in writing by Christman, Subcontractor shall do all cutting, fitting, and patching of its Work that may be required to make its several parts come together properly and to fit it to receive or be received by work of others.

10.16 Employment Practices Subcontractor shall not discriminate against any person with respect to his/her hire, tenure, terms, conditions or privileges of employment because of race, color, age, sex, religion, sexual orientation, the presence of a physical, sensory or mental disability, or national origin. Subcontractor shall comply with any and all Applicable Laws as to fair employment practices and other employment programs required by the Contract Documents.

10.17 Conduct Subcontractor and its Lower Tiers shall not engage in any harassment or offensive behavior. Christman strictly prohibits any request to engage in illegal or unethical conduct and negative comments or actions based on race, color, age, sex, religion, sexual orientation, physical, sensory or mental disability, or national origin. Subcontractor shall immediately address any claim of harassment or offensive behavior involving it or its Lower Tiers, properly discipline any person who engaged in such conduct, including removal from the Project where appropriate, and use its best efforts to ensure that such conduct does not reoccur. In its sole judgment, Christman shall have the right to cause removal from the Project any worker who engages in unsafe work practices or violates this Article.

10.18 Recordkeeping Subcontractor shall keep full and detailed accounts and exercise such controls as may be necessary for proper financial management, using accounting and control systems in accordance with generally accepted accounting principles.

During the Work and for a period of 3 years after final payment, Christman and/or Owner and their accountants shall be afforded access to and the right to periodically audit, upon reasonable notice, Subcontractor's records, books, receipts, subcontracts, purchase orders, man hours and equipment hours, and other data relating to the Work, all of which Subcontractor shall preserve for 3 years, or such longer period as specified in the Prime Contract.

10.19 Operation Manuals Upon approval of shop drawings and Submittals, Subcontractor shall provide an electronic copy (unless some other form is specified in the Prime Contract) of Operation and Maintenance Manuals for each item approved, as applicable.

ARTICLE 11 - WARRANTY

11.1 Warranty Subcontractor warrants that the Work shall strictly conform to the requirements of the Contract Documents and shall be free from defects in design, workmanship, and materials. Subcontractor shall promptly correct any defective or nonconforming Work, by (at Christman's exclusive option) adjustment, repair, or replacement to the satisfaction of Christman and Owner. Subcontractor shall pay all costs associated with accessing the Work to make warranty repairs and returning the Work and all affected surrounding work to the condition required by the Contract Documents. If Christman determines that Subcontractor is not timely completing its warranty obligation, Christman may replace or repair, at its sole election, and backcharge Subcontractor all associated costs. If no sums remain due Subcontractor, Subcontractor shall pay Christman all those costs immediately upon demand.

11.2 Duration The Subcontractor shall provide a one (1) year warranty from the actual Project "Substantial Completion Date" on all material, equipment and workmanship, or the warranty duration specified in the Contract Documents, whichever is longer. For any portion of the Work repaired or replaced, Subcontractor shall provide an additional one (1) year, or longer if the Contract Documents require, warranty on the Work after the date of repair or replacement.

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11.3 Statutory Warranty Nothing in this Article shall limit the rights afforded to Christman and Owner under Applicable Law as to Subcontractor's warranty against defects in design, workmanship and materials or defective or non-conforming Work, nor shall this Article limit any statutory period of liability for warranty, design, and latent defects.

ARTICLE 12 - PAYMENT

12.1 Schedule of Values Subcontractor shall submit all payment, insurance and other compliance documents through Christman's Trade Contractor Portal. Within the time required by Christman, Subcontractor shall submit for review, through the Trade Contractor Portal, a detailed schedule of values (SOV) on AIA Form G703 or equivalent. The SOV shall be itemized into discrete items and areas of Work and include labor and material breakdowns for each work item, general conditions, mobilization, demobilization, punch list, and administrative close out, with no less than 5% designated for close out. For any allocation for mobilization, there must be an equal allocation for demobilization. To the extent practicable and subject to Christman's approval, the SOV shall not contain a single line item greater than 5% of the Contract Sum. Christman shall have the right to require modification at any time of the SOV to align with proper allocation of scopes of work and distribution of resources. Christman will not process a payment application until Subcontractor revises or corrects the SOV to account for imbalance, errors or irregularities.

12.2 Conditions To the extent permitted by Applicable Laws, for Subcontractor's complete, timely, and satisfactory performance of the Work, Christman will pay Subcontractor out of such equivalent payment Christman receives from Owner for Subcontractor's Work. Christman will pay Subcontractor within 7 days after Christman receives Owner's payment, less retainage held by Owner or Christman. To the extent permitted by Applicable Laws, Christman's receipt of Owner's payment is an absolute condition precedent to Christman's obligation to pay Subcontractor. If Christman has furnished a payment or performance bond, the obligations of Christman and its surety to make progress payments or final payment is subject to the absolute condition precedent of Owner prior payment. Christman's surety is a third party beneficiary of this condition precedent. Christman's payment to Subcontractor shall not be construed as an admission by Christman of the classification, quantity, quality, or sufficiency of Work done, or as an acceptance or release of Subcontractor's responsibility under this Agreement. Also to the extent permitted by Applicable Law, as an absolute condition precedent to Christman's obligation to pay Subcontractor and using Christman's Trade Contractor Portal, Subcontractor shall timely furnish with each payment request: (a) a satisfactory sworn statement sworn by an officer of Subcontractor; (b) conditional waivers of lien from Subcontractor and its Lower Tiers for the current payment application; (c)

unconditional waivers of lien or bond claims by Subcontractor and its Lower Tiers reflecting Christman's previous payments; (d) payrolls and, if required by the Prime Contract, weekly certified payrolls in compliance with Applicable Laws; and (e) any other information or documents reasonably requested by Christman. The form and content of all submissions shall be satisfactory to Christman. Sworn statements must include a complete and accurate list of all Lower Tiers including equipment lessors and any entity entitled to assert a lien or bond claim.

12.3 Process On the date of the month specified by Christman, Subcontractor shall submit a payment application in the form and manner specified by Christman, detailing costs accrued and percent of Work complete, through the time period of the month specified by Christman. Subcontractor's determination of percentage of work complete is subject to the approval of Christman, Owner, and/or Architect. Any application not timely submitted may not be included in Christman's payment application to Owner. Subcontractor shall not request payment for any Work for which it does not intend to promptly pay its Lower Tiers. Payment for all materials stored offsite is solely at Christman's discretion.

12.4 Cost Reimbursable Items If Subcontractor is entitled to reimbursement of any costs incurred for the Work (Reimbursable Costs), such as approved Change Order work, payment of Reimbursable Costs shall be made in accordance with cost reimbursement terms of the Prime Contract, or in the absence of such terms, in accordance with this Agreement. Subcontractor shall maintain, in a manner and quality satisfactory to Christman, accounting records for Reimbursable Costs, including, without limitation, Lower Tier invoices, material receiving reports, segregated cost data, payrolls, labor hours, equipment hours, and other documentation necessary to fully substantiate each Reimbursable Cost. These records shall be subject to audit by Christman, the Owner or their designated representatives.

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12.5 Joint Payment Subcontractor authorizes Christman to communicate with Subcontractor's Lower Tiers on payment issues and to make payment via joint check to any Lower Tier if, in Christman's sole discretion, Christman determines that joint checks are necessary or appropriate. Subcontractor gives this authorization without the need for any further joint-check arrangement. Christman's payment by joint check shall be deemed to be made directly to Subcontractor. Christman may issue a joint check for the amount shown on Subcontractor's Sworn Statement as due to Lower Tiers, less any setoffs, backcharges, warranty work, or other deductions to which Christman may be entitled. Subcontractor waives any claim against Christman for any errors that may arise out of a joint check payment and accepts responsibility for the validity any endorsements of any joint check. Christman's right to pay by joint check does not create any obligation to do so, and no joint check payee or third party shall have third party beneficiary or other rights to demand joint payment.

12.6 Removal of Claims Provided Christman has paid Subcontractor in accordance with this Agreement, within 3 days of Christman's written request, Subcontractor shall cause to be discharged any Lower Tier lien or bond claim related to the Work. If Subcontractor fails to do so, Christman, at its sole discretion, may use whatever means necessary to remove such suit, claim or lien and backcharge Subcontractor the cost of so doing. Subcontractor shall be responsible for any costs, including attorney fees, litigation costs, and consultant fees that Christman incurs in removing or attempting to remove such suit, claim or lien, plus a markup of 20% for administrative and overhead expenses (Contractor Markup). If Owner or Christman receive any lien, bond claim or notice of intent to file, Christman may withhold the full amount of such claim, plus Contractor Markup pending adjustment. If Subcontractor defaults in payment of its debts on the Project, Christman shall have the right to pay such debts and charge them to Subcontractor. If Christman determines, in its sole discretion, that the balance of the Contract Sum then remaining unpaid will not be sufficient to complete the Work in accordance with the Contract Documents, no additional payments will be due Subcontractor unless Subcontractor, at no cost to Christman, performs, and pays in full for, a sufficient portion of the Work such that the balance of the Contract Sum then remaining, as determined by Christman, is sufficient to complete the Work.

12.7 Trust Fund Subcontractor shall hold each payment from Christman in trust to satisfy all indebtedness to Lower Tiers first, before paying any other indebtedness of the Subcontractor.

12.8 Withholding Christman may withhold payment to Subcontractor or set off any payment for any of the following reasons: (a) failure to remedy defective Work or perform clean-up; (b) off-site fabrication not meeting production quotas or quality standards; (c) Subcontractor has damaged any portion of its Work or the work of others; (d) claims, levies, liens, attachments, stop notices or court orders or reasonable evidence indicating probable filing of such claims, including unpaid insurance claims arising out of the

Work; (e) allegations that Subcontractor has not timely paid employees or Lower Tiers or Subcontractor fails to produce proof requested by Christman of such payments; (f) there exists reasonable doubt in Christman's sole discretion that the Work can be completed for the unpaid balance of the Contract Sum or within the Project Schedule; (g) unsatisfactory prosecution of the Work; (h) failure to deliver current insurance certificates, bonds, submittals, shop drawings, SOVs, "as built" drawings, written guarantees or warranties, or the approvals required of the Work by any authority having jurisdiction; (i) Christman is exposed to an Owner claim for liquidated damages arising in whole or in part from the Work; (j) a petition for bankruptcy or reorganization is filed by or against Subcontractor or Subcontractor has made an assignment without Christman's prior written consent; (k) Subcontractor is unlicensed or its license is invalid or lapsed; (l) any violation of Applicable Laws; (m) Subcontractor expresses an intent to repudiate the Agreement or reduce its work force, equipment, or materials; and (n) any circumstance that would constitute a Subcontractor Default, even if Christman has not declared a Subcontractor Default.

12.9 Contract Balance Subject to the absolute conditions precedent in this Article and Applicable Laws, the balance of the Contract Sum (Contract Balance) is defined as that amount payable to Subcontractor after Christman exercises any right to withhold or offset the Contract Sum. The Contract Balance does not include pending or disputed change order work. No Subcontractor surety bond shall alter this definition or prevent Christman's exercise of the right to withhold or setoff before making any Contract Balance available to surety under any bond.

12.10 Final Payment As an absolute condition precedent to Christman's obligation to make final payment of the Contract Balance to Subcontractor, Subcontractor shall submit to Christman: (a) an affidavit to Christman's satisfaction that Subcontractor has paid all indebtedness connected with the Work; (b) consent of surety, if required by Christman; (c) satisfaction of required closeout procedures and documentation; (d) receipts, releases, and waivers of lien and/or bonds in the form designated by Christman or Owner and other satisfactory evidence that there are no liens, bond claims, or other indebtedness related to the Work; and (e) Subcontractor's written Warranty. Upon Subcontractor's satisfaction of this condition precedent, after Subcontractor's application for final payment, and after Owner's acceptance of and payment for all Work, Christman shall pay the Contract Balance to Subcontractor. If Owner asserts a claim for, or assesses and retains against Christman any liquidated damages, Christman's payments to Subcontractor shall be reduced to the extent such assessment is attributable to Subcontractor. Subcontractor shall not assert a claim for retention until Owner's assessment of liquidated damages is finally resolved. Subcontractor's acceptance of final payment shall be deemed a final waiver of all claims of any nature against the Owner and Christman, but shall not relieve Subcontractor of liability for indemnity and warranty obligations, or for faulty or defective work appearing before or after final payment. To the extent permissible by Applicable Laws, all payments, including final payment, shall be out of such equivalent payments Christman receives from the Owner. Christman's receipt of such payments is an absolute condition precedent to payment to Subcontractor.

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ARTICLE 13 - CHANGES AND EXTRA WORK

13.1 Changes Without invalidating this Agreement, Christman may make any changes by altering, adding to, or reducing the extent and/or scope of the Work, including the deletion of any major items of work to be completed. Except as provided below, no change in the extent or scope of such Work shall be made except by a Change Order signed by Christman. The charge or credit for any such changes shall be determined, at Christman's option, by any of the following methods: (a) agreed upon lump sum price; (b) unit prices named in this Agreement or subsequently agreed upon in writing; or (c) time and material. Subcontractor shall submit for approval a quotation covering any change in the Work which affects the Contract Sum. The quotation shall contain a detailed itemization of costs and shall identify any impact on the Project Schedule, Subcontractor's progress of the Work, milestone dates, and/or the Substantial Completion date. Subcontractor shall submit its quotation within 7 days' of receipt of notification of the change, or such shorter time as Christman directs. If the Parties cannot agree about whether there exists a change in the Work or cannot agree on the amount of the addition or deletion, to maintain the Project Schedule, pending final resolution of the Change Order, Subcontractor shall nonetheless timely perform the Work as changed by Christman's written direction and proceed in accordance with Article 13.4.

13.2 Written Authorization Subcontractor shall not perform any changes or additional work except upon Christman's prior written direction. If Subcontractor proceeds without such written authority, Subcontractor expressly waives any and all claims for additional payment. No oral or other claimed waiver of the requirement of prior written authority shall be binding. An increase in the Contract Sum by virtue of such change shall not occur until a Change Order has been issued and signed by Christman and

Subcontractor, and, for Owner or Architect initiated changes, Owner has signed a Change Order. Any adjustment in the Contract Sum, Project Schedule or other provisions as set forth in each Change Order shall operate as an Accord and Satisfaction and shall constitute the full, final and complete compensation to Subcontractor for the entire cost and schedule effect related to the stated changes and the cumulative impact and effect resulting from the stated changes on all prior Work and prior changes in the Work. Subcontractor waives any claims for any other additional compensation, damages or time extensions in connection with the stated changes. The Contract Sum may be equitably adjusted by Christman by written Change Order or directive issued by Christman, with or without Subcontractor's consent, for reasonable backcharges and adjustments to the Contract Sum permitted under this Agreement.

13.3 Signature With the exception of backcharges, all Change Orders must be approved and signed either by Christman's representative who executed this Agreement or another representative on the same or higher level of authority. No changes to the Agreement may be made or agreed to by any field personnel. Email, texts, or other electronic means of communications shall not be sufficient to establish a Change Order. Field representatives may not authorize or sign for changes in the Work or additional work and do not have any authority to agree to or approve changes. Superintendents may sign time tickets for the sole purpose of documenting time on the Project; under no circumstances shall such signature be deemed to accept or authorize additional work or otherwise obligate Christman to pay for such work, notwithstanding any language on Subcontractor's time ticket or other documentation to the contrary.

13.4 Claims If Subcontractor intends to assert any claim for additional compensation or schedule extension, as an absolute condition precedent to such claim, Subcontractor's notice and claim shall strictly conform to Articles 14 and 15.

ARTICLE 14 - TIME

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14.1 Schedule Time is of the essence. Within the time specified by Christman, Subcontractor shall provide Christman with scheduling information and a proposed schedule for performing the Work which shall include a projection of labor hours and crew sizes, all in forms acceptable to Christman. Subcontractor's proposed schedule shall conform to the Project Schedule and all revisions or changes made to the Project Schedule from time-to-time. Subcontractor shall maintain the specified rate of progress for its Work and shall complete the Work on or before the dates set by Christman for Subcontractor's Work. Subcontractor shall perform the Work in a prompt and diligent manner without delaying or hindering the work of others. The Project Schedule is not a representation by Christman that Subcontractor will be able to perform its activities on certain dates. Subcontractor acknowledges that as construction progresses it may be necessary for Christman to change the sequential order and duration of activities to account for unanticipated delays, occurrences, and other factors that alter Christman's schedule. Christman may require Subcontractor, at no additional cost to Christman, to prosecute the Work in such sequence as the progress of other trades and the Project Schedule reasonably dictate. Scheduling may require temporary omission of the Work at locations determined by Christman. All patches, fill-in and "come back" work for the proper completion of the Work shall be included in the Contract Sum. Subcontractor expressly agrees that the reasonable scheduling and sequencing of the Work is Christman's exclusive right and that Christman reserves the right to reasonably reschedule and re-sequence the Work from time to time as the demands of the Project require without additional cost or expense to be paid to Subcontractor. Christman's exercise of any rights or remedies under this Agreement, including ordering changes in the Work, directing suspension, rescheduling or correction of the Work, regardless of the extent or frequency of Christman's exercise of such rights or remedies shall not be construed as active or unreasonable interference with Subcontractor's performance of the Work.

14.2 Failure to Progress If Subcontractor delays or disrupts the progress of any work, Subcontractor shall, at its own cost and expense, take such action as Christman deems necessary or appropriate to improve Subcontractor's rate of progress, including, but not limited to, increasing the number of superintendents, foemen, skilled and unskilled labor, increasing the number of crews and or shifts, employing more or better equipment, working overtime, expediting delivery of materials, changing sequence of performance, prosecuting parts of the Work in preference to other parts, and any other increase or acceleration effort to avoid or mitigate delays. Subcontractor shall be subject to liquidated or other damages on the basis stated in the Prime Contract if Subcontractor causes or contributes, in whole or in part, to any delay, even if concurrent, which would allow the Owner to assess liquidated or other damages against Christman. Regardless of whether liquidated damages are specified, Subcontractor shall be liable to Christman for any loss, damage or liability of Christman, caused in whole or in part by delays, disruptions or other reasons attributable to Subcontractor.

14.3 Cure If Subcontractor fails to correct, replace and/or re-execute faulty or defective Work or materials, fails to maintain the progress of its Work in a timely and proper manner and with such effort, speed and diligence to maintain the Project Schedule, current revisions of milestone dates, interim completion dates, activity durations, or otherwise fails to facilitate the orderly progress of the Project, or is unable to proceed with the Work because of any labor dispute, then Christman, upon 48 hours' notice to Subcontractor, shall have the right to correct, replace and/or re-execute such faulty, defective, damaged or delayed work, or to supplement Subcontractor's crews, or to take over this Agreement with all materials of the Subcontractor on the site and complete the remaining Work, charging such cost to Subcontractor. Under such circumstances, Christman shall also have the right to withhold payments to Subcontractor until Subcontractor pays Christman in full for such costs.

14.4 Time Extension If, without fault or cause by Subcontractor, Subcontractor's performance is delayed, and provided that such delay is not concurrent with a delay caused by Subcontractor, Subcontractor may request an extension of time for performance, but shall not be entitled to any increase in the Contract Sum, any additional compensation, damages for schedule compression, acceleration, stacking, or loss of labor/equipment productivity, or consequential damages, as a result of such delays, such extension of time for performance being Subcontractor's sole and exclusive remedy for any schedule or delay related claim. Notwithstanding the foregoing, Christman will cooperate with Subcontractor in submitting to Owner any just claim arising from delay which is permitted by the Contract Documents and by applicable law.

14.5 Claims Any claim for a time extension shall strictly comply with the Claim provisions in Article 15.

ARTICLE 15 - CLAIMS

Sample

15.1 Owner Claims For any claim by Subcontractor seeking payment of money or a schedule extension because of any act, failure to act, default or interference by the Owner and/or the Architect, and/or their respective subcontractor or suppliers, the Subcontractor shall carefully observe all terms and conditions of the Prime Contract relating to claims and shall give Christman timely written notice of such claim in the form required by the Prime Contract. Subcontractor shall specifically label the notice a "Notice of Claim." Unless expressly prohibited by Applicable Laws, Subcontractor shall provide such notice, no later than 5 days before the time Christman is required to make such claim to the Owner under the Prime Contract, or within 5 days of the beginning of the event giving rise to the claim, whichever is earlier. Subcontractor shall not claim any time extension, cost reimbursement, compensation, or damages for any delay, disruption, or interference except to the extent that Christman is entitled to a corresponding time extension, cost reimbursement, compensation, or damages from Owner under the Contract Documents and Applicable Laws. Subcontractor shall be solely responsible for all attorneys' fees, costs, and expenses (Pursuit Costs) Christman incurs in submitting such claim and shall reimburse Christman on a monthly basis for Pursuit Costs. Subcontractor's recovery shall be limited to the amount, if any, that Christman actually receives from Owner for Subcontractor's claim. To the extent permitted by Applicable Laws, Owner's payment to Christman for such claim shall be an express condition precedent to Christman's duty of payment to Subcontractor.

15.2 Contractor Claims For any claim by Subcontractor against Christman seeking payment of money or a schedule extension or other relief with respect to the terms of this Agreement because of any claimed act, failure to act, default or interference by Christman or Christman's other subcontractors, Subcontractor shall give Christman written notice no later than 5 days from the beginning of the event giving rise to the claim. Such notice shall be specifically labeled a "Notice of Claim" and served in accordance with 15.5.

15.3 Claim Substantiation For all claims, within 14 days of providing a timely Notice of Claim, Subcontractor shall provide Christman with: (a) detailed actual cost records supporting the claim and identifying the actual discrete costs attributable to the claim; (b) an affidavit under oath by an officer of Subcontractor certifying and stating (a) the specific relief sought; if money is sought, the specific dollar amount sought; (b) that the actual discrete costs claimed are true and correct. The affidavit must contain or attach sufficient supporting documentation to reasonably allow its consideration, including without limitation, any documentation required by the Contract Documents.

15.4 Claim Calculation Subcontractor agrees that the total cost approach of calculating damages, or variations thereof (collectively, TCA) or any other method of calculating claims through estimating based upon the measured mile analysis (MMA),

earned value analysis (EVA), or the use of industry standards, is inherently unreliable and uncertain. Therefore, Subcontractor waives any damages based on the TCA, MMA, or EVA, and/or any claim based on estimated costs or industry guidelines such as the Mechanical Contractors Association of America, the National Electrical Contractors Association, or any other organization. As an absolute condition precedent to any claim, claims must be based upon a discrete actual costs analysis supported by contemporaneously (daily) documented actual costs properly allocated to the claim. Subcontractor waives any claim not contemporaneously documented and properly allocated. If Christman receives Subcontractor daily time reports, such receipt shall be deemed solely for documentation purposes and not as an admission of quantity, validity or liability of a claim.

15.5 Delivery of Notice For all claims, Subcontractor shall provide written notice via certified or registered mail to the address on page 1 of this Agreement. **EMAIL OR FACSIMILE OF A NOTICE OF CLAIM IS PROHIBITTED AND IS INSUFFICIENT TO ESTABLISH NOTICE.**

15.6 Strict Compliance Subcontractor's strict compliance with all claim requirements (timely notice, form, substantiation, calculation and delivery) is a strict and absolute condition precedent to any claim and the failure to adhere to any one of these requirements is an absolute defense to the claim. Subcontractor waives any claim that does not strictly comply with Article 15 and Christman shall not be liable to Subcontractor on any claim not timely or properly presented. Christman's actual or constructive notice of a claim shall not satisfy or excuse Subcontractor from strict compliance nor prevent Subcontractor's waiver of the claim. If Subcontractor does not strictly comply with this Article or if Christman cannot in good faith certify or submit Subcontractor's Owner Related Dispute to Owner, Christman is not obligated to do so.

ARTICLE 16 - DISPUTE RESOLUTION

16.1 Owner Related Disputes In case of any dispute between Christman and Subcontractor, which in Christman's sole opinion is in any way related to or arising from any act or omission of the Owner or Architect/Engineer, (Owner Related Dispute), Subcontractor shall be bound to Christman to the same extent that Christman is bound to Owner by the Contract Documents and by any and all preliminary and final decisions, determinations or agreements made by Christman and Owner or so authorized in the Contract Documents or by the court or arbitrator designated in the Contract Documents whether or not Subcontractor is a party to such agreement or proceeding. Subcontractor shall stay any and all legal actions against Christman or its surety until a final non-appealable decision has been obtained from or against the Owner as to the Owner Related Dispute. Christman and its surety shall not be liable to Subcontractor in excess of any sum actually received from Owner for Subcontractor's Owner Related Dispute. Unless expressly prohibited by Applicable Laws, Christman's receipt of payment from the Owner for Subcontractor's Owner Related Dispute is a strict condition precedent to Christman's and its surety's obligation to pay Subcontractor.

Sample

16.2 All Other Disputes All disputes arising out of or relating to this Agreement or any performance or payment bonds furnished by either party shall first be resolved in the following order: (1) by a meeting of the project management on site, within 7 days of the date a party requests such meeting; (2) if that fails, by a meeting of the principals in charge for each Party within 10 days following the project management site meeting; (3) if that fails, within 30 days after the principals in charge meeting, by mediation where the Parties select a mediator, the costs of which shall be shared equally. All disputes and claims that are not disposed of as provided herein shall be resolved by submission to the state or federal court whose district includes the county where the Project is located (Controlling Venue). The Controlling Venue is the exclusive venue for any claim and litigation may only be filed in that county. Subcontractor consents to personal jurisdiction in any court whose jurisdiction includes the Controlling County. **The Parties waive their right to a trial by jury and acknowledges that they have had the opportunity to seek the advice of legal counsel before waiving this right**.

16.3 No Stop Work Pending the resolution of any dispute, Subcontractor, without waiver of its other rights and remedies, shall not stop work or reduce its labor force, equipment, or progress, and shall diligently proceed with the Work.

ARTICLE 17 - DEFAULT AND TERMINATION

17.1 Adequate Assurance If at any time Christman deems in its sole discretion, that there are reasonable grounds of insecurity as to Subcontractor's ability to properly and timely perform, Christman may give Subcontractor written demand for adequate assurance of performance. Subcontractor shall provide such assurance, reasonably acceptable to Christman, within 10 days after Subcontractor's receipt of written demand.

17.2 Subcontractor Default Any of the following shall be considered a Subcontractor Default: (a) default in the performance of any requirement of this Agreement or the Prime Contract insofar as the Work; (b) failure to provide a sufficient crew of skilled workers and proper quantity and quality of equipment and materials as and when required; (c) failure to maintain the progress of its Work in a timely and proper manner and with such effort, speed and diligence to maintain the Project Schedule, current revisions of milestone dates, interim completion dates, activity durations, or otherwise failing to facilitate the orderly progress of the Project as a whole; (d) reduction in work force, equipment or materials, or abandonment of portions of the Work; (e) interference with the performance of others on the Project; (f) failure to timely pay any Employer Contributions, labor employed by Subcontractor, or any Lower Tiers; (g) failure to pay or to maintain satisfactory credit relationships for the purchase of labor, supplies, materials, equipment, and services; (h) repudiation or anticipatory repudiation of all or part of the Agreement; (i) failure to provide adequate assurance of timely performance; (j) failure to timely remedy any defects in Work; or (k) failure to perform in strict accordance with Christman's safety requirements.

17.3 Notice to Cure / Remedies If Subcontractor commits a Default and fails to commence and continue satisfactory correction of the Default within 48 hours after receipt of a written Notice of Default, then Christman, at its option, and in its sole discretion, and without prejudice to any other right or remedy, shall have the immediate right to any or all of the following remedies: (a) supplement Subcontractor's Work; (b) enter on the site of the Work and take possession of, for the purpose of completing the Work, Subcontractor's material; (c) employ any other person or persons to finish the Work; (d) provide materials or equipment to complete the Work; (e) terminate Subcontractor and/or Subcontractor's right to proceed; or (f) take whatever other or additional steps Christman deems, in its sole discretion, are in the best interests of Christman or the Project. Notwithstanding the terms of any surety bond to the contrary, Christman shall have the absolute right to exercise any remedy at the cost of Subcontractor or its sureties and shall have the right to enforce any bond right if Subcontractor is declared in Default, during Subcontractor's attempted cure of Default, and/or during surety's investigation of Default. Christman's exercise of any remedy shall not be deemed to impair, prejudice, extinguish, or otherwise diminish any obligation of Subcontractor's surety, nor shall it impair, prejudice, extinguish or diminish the rights of Christman under any such bond.

Sample

17.4 Assignment If Christman elects in writing, in its sole discretion, and effective only upon Christman's termination of Subcontractor's right to proceed, Subcontractor shall assign to Christman any Lower Tier contract for the Work. Subcontractor shall include provisions in its Lower Tier contracts for such assignment without further consent of such Lower Tiers.

17.5 Set Off Christman shall be entitled to recover from Subcontractor and its sureties (as applicable), all expenses, damages, and liabilities Christman incurs as a result of a Default including the cost of labor and materials to complete the Work, acceleration costs incurred in performing the work or engaging others to perform the Work, costs paid to other subcontractors, additional supervision, consultant fees, attorney's fees, and liquidated damages, plus Contractor Markup (collectively, Default Damages). Christman shall have the immediate right to offset or deduct the Default Damages from any money due or to become due to Subcontractor and thereby reduce any unpaid balance of the Contract Sum, notwithstanding any term in a surety bond to the contrary. Subcontractor and its sureties shall remain liable to Christman for Default Damages as they continue to accrue, without waiver of or prejudice to any other right, remedy or claim Christman may have. If a Default occurs, Subcontractor shall not be entitled to any further payment until Owner finally accepts the Work, and until after Christman offsets or deducts Default Damages. If the Default Damages exceed the unpaid balance of the Contract Sum, then Subcontractor and/or its surety shall pay the difference to Christman. If it is determined, by litigation, arbitration or otherwise, that any remedy exercised by Christman, including a termination for Default, was unjustified, such remedy or termination shall be deemed for convenience and Subcontractor's remedies shall be limited to those provided for as a termination for convenience.

17.6 Termination for Convenience Christman may terminate this Agreement for convenience by written notice to Subcontractor for any reason provided in the Prime Contract or within Christman's sole discretion. If a Termination for Convenience occurs, Christman shall only be obligated to pay Subcontractor, as otherwise provided for and in accordance with the terms of this Agreement, and as Subcontractor's sole and exclusive remedy: (a) that portion of the cost of the Work allocable to the portion of the Project satisfactorily performed by Subcontractor before the effective date of termination, plus reasonable overhead and profit on such work; and (b) demobilization costs as properly substantiated by proof acceptable to Christman. Under no circumstances shall Subcontractor be entitled to recover for profit and overhead on work not performed before the notice of termination for

convenience.

ARTICLE 18 - MISCELLANEOUS

18.1 Calendar Day All references in this Agreement to days shall mean calendar days.

18.2 Assignment Subcontractor shall not assign or subcontract this Agreement or any portion thereof, nor assign any payment, claims or rights under this Agreement to any third party without Christman's prior written consent. Consent will not be given to any proposed agreement that would relieve the Subcontractor or its surety of their responsibilities under this Agreement. Christman may assign this Agreement to its surety, joint venture partner, an affiliate, or other third party. Christman may also assign this Agreement to Owner, its designated assignee, or lender, in accordance with the terms of the Prime Contract or Owner's loan documents associated with the Project.

18.3 Ownership of Work Product Subcontractor grants to Christman and the Owner if required by the Prime Contract, all ownership and property interests in all Subcontractor Work Product. To the extent Subcontractor Work Product includes or otherwise utilizes trade secrets, copyrighted materials or other similarly protected intellectual property, Subcontractor grants to Christman a license for the use of such Work Product solely and exclusively for the Project.

18.4 Data Ownership & Confidentiality Engineering, architectural, or other information provided pursuant to this Agreement is the property of Christman (or the Owner if so provided in the Prime Contract) and is not to be reproduced or disclosed to others or used for other purposes without Christman's written permission. All information about the Project. Christman's systems, processes, procedures, and other operations, and the Owner's systems, processes, procedures, and business operations shall be kept strictly confidential by Subcontractor and its Lower Tiers unless otherwise prohibited by Applicable Laws or to the extent exceptions are permitted by written approval from Christman. If confidential information is disclosed by Subcontractor or its Lower Tiers, Subcontractor shall immediately notify Christman of the unauthorized disclosure and details pertaining to what was disclosed, to whom and when the disclosure occurred. Subcontractor shall be responsible to Christman and to the extent applicable in the Prime Contract, to the Owner for any unauthorized disclosure.

Sample

18.5 E-Data Except as to a Notice of Claim, the parties may exchange and execute records in electronic form. Christman disclaims any representation or warranty as to the functionality of the software or computer program associated with electronic transmission of records. Christman disclaims any warranty, express or implied, including the warranty of fitness for a particular purpose, as to the information transmitted in electronic form.

18.6 Integration This Agreement including incorporated documents is the entire agreement between the Parties, supersedes and cancels any prior written or verbal agreements, and constitutes the only agreement between the Parties for the Work and the Project. Except for Christman backcharges to Subcontractor, no terms of this Agreement or the nature and extent of the Work shall be waived, modified, reduced, or enlarged, except in writing signed by both Parties. No additional or contrary term in any Subcontractor document related to this Agreement is binding on Christman.

18.7 Controlling Law This Agreement is governed by the law of the Controlling State and to the extent applicable, all federal laws, rules and regulations. The term "State" includes all 50 states, the District of Columbia, Puerto Rico, and any other unincorporated territory of the U.S.

18.8 Independent Contractor Subcontractor shall be deemed to be an independent contractor fully responsible for the means, methods and safety measures and procedures utilized fulfilling the scope of services or terms of this Agreement. Under no circumstances shall the Subcontractor be deemed to be an employee or joint venturer with Christman.

18.9 Authority Subcontractor affirms that its signatory to this Agreement is an authorized agent of Subcontractor, with full authority to enter into this Agreement on behalf of Subcontractor. This Agreement may be executed electronically and a copy of a signed Agreement may be exchanged via email in which case signatures shall be deemed binding for all purposes and an original signature is not required.

18.10 Severability If any portion of this Agreement is deemed invalid or unenforceable, such term may be severed from this Agreement and the remainder of the Agreement shall be valid and enforceable to the fullest extent permitted by law.

18.11 Work Before Signing Subcontractor's liabilities and obligations to Christman hereunder shall apply to all the Work, even Work that may have been performed before the date of this Agreement pursuant to prior negotiations, representations, agreements, understandings or otherwise. Notwithstanding a later signing of this Agreement by Christman or Subcontractor, this Agreement is deemed effective on the date Subcontractor first commences any Work.

18.12 Enforcement Christman's failure to insist in any one or more instances on Subcontractor's performance of any term or condition of this Agreement, or failure to exercise any of its rights, shall not constitute waiver or relinquishment of such term, condition, or right as to further performance or Christman's right to enforce any term or condition. Christman's waiver of any term, condition, or rights shall be made in writing and such written waiver shall not be deemed a waiver of any other term or condition.

ARTICLE 19 - EXHIBITS

The following Exhibits, whether attached hereto or not, are incorporated by reference.

Exhibit I	Supplement A
Exhibit II	Christman's Safety Program
Exhibit III	Payment & Performance Bonds
Exhibit IV	Supplement B, if applicable

Sample

[SIGNATURE PAGE TO FOLLOW]

Job No. **Work Category:**

ACCEPTANCE

The said parties, for themselves, their heirs, successors, executors, and administrators and assignees, do hereby agree to the full performance and covenants contained herein.

By signing below these parties affirm that they are each authorized agents of their respective organizations, with full rights and privileges to enter into this Agreement on behalf of those respective organizations. This Agreement may be executed by facsimile signature, or a copy of a signed Agreement may be delivered via email by either party and such signature will be deemed binding for all purposes hereof without delivery of an original signature being thereafter required.

Signature	Signature
Print Name	Print Name
Title	Title
Date	Date

Sample

SUBCONTRACTOR PAYMENT BOND

BOND NUMBER: _____

SUBCONTRACTOR: _____
Address: _____

SURETY: (or Sureties) _____
Address: _____
Phone Number: _____
Email: _____

CONTRACTOR: **THE CHRISTMAN COMPANY**
Address: 208 N. Capitol Avenue, Lansing, MI 48933

PROJECT: _____

SUBCONTRACT DATE: _____

CONTRACT AMOUNT: $ _____

BOND AMOUNT: _____ Dollars
($)

Contractor has entered into a Subcontract or Purchase Order (Agreement) with Subcontractor in the amount stated above (Contract Amount) for the Project for the performance of work, including warranty obligations (Work), as detailed in the Agreement. That Agreement is incorporated by reference in its entirety into this Bond.

By virtue of this Bond, Subcontractor and Surety are held and firmly bound to Contractor to pay for labor, materials, and equipment (collectively, "Improvements") furnished for use in performing the Work and agree to bind themselves and their respective heirs, administrators, executors, successors and permitted assigns, jointly and severally, firmly as follows:

1. **Payment Made** If Subcontractor promptly pays all sums due Claimants and defends, indemnifies and holds harmless Contractor from claims, demands, liens or suits by any person or entity seeking payment for Improvements furnished for use in performing the Work, then Subcontractor and Surety shall have no obligation under the Bond.

2. **Surety Obligation to Contractor** Surety's obligations to Contractor shall arise after Contractor notifies Surety and Subcontractor in writing of claims, demands, liens or suits against Contractor or the real property upon which the Project is located, by any person or entity seeking payment for Improvements. Upon such notice, Surety shall promptly, and at Surety's expense, defend, indemnify and hold Contractor harmless from such claim, demand, lien or suit.

3. **Surety Obligation to Claimant** Every Claimant who has not been paid in full before the expiration of ninety (90) days after Claimant provided or performed the last of the Work, or furnished the last of the Improvements for which the claim is made, may have a right of action on this Bond. The Surety's obligation shall not exceed the Bond Sum, as modified.

4. **Limitation of Action** Claimant shall not commence any suit or action on this Bond:

   a. Unless Claimant, except a Claimant having a direct contract with Subcontractor, shall have given written notice of non-payment to Subcontractor, Contractor and Surety within ninety (90) days after Claimant last performed or furnished the Improvements for which the claim is made, stating with substantial accuracy the amount claimed and the name of the party to whom Claimant provided the Improvements. Claimant shall serve such notice to the addresses set forth in this Bond. And, after the expiration of one (1) year from the date when Claimant last performed or provided Improvements to the Project. If this provision is prohibited by law, the minimum period of limitation available to surety in the jurisdiction shall apply; and,
   b. Other than in any court of competent jurisdiction in the location where the Project is located.

5. **Contractor Notice** Contractor's written notice to Subcontractor and Surety of Claimant's claim, served by Contractor to the addresses set forth in this Bond, shall be sufficient to satisfy Claimant's obligation in paragraph 4(a) to furnish notice. Contractor's notice in the form of email with delivery or read-receipt verification shall be sufficient written notice. Notwithstanding the foregoing, Contractor shall have no affirmative obligation to Claimant, Subcontractor or Surety to provide notice on behalf of Claimant.

SUBCONTRACTOR PAYMENT BOND

BOND NUMBER: _____

6. **Surety Response** When the conditions of paragraph 4(a) are satisfied, Surety shall promptly, and at Surety's expense, take the following actions:

    a. Provide a written response to Claimant, with a copy to Subcontractor, within forty-five (45) days after receipt of the Claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed; and,
    b. Pay any undisputed amounts.

7. **Claimant** Claimant means an individual or entity having a direct contract with Subcontractor, or with a subcontractor or vendor of the Subcontractor, to provide Improvements. The term Claimant also includes any individual or entity that has rightfully asserted a claim under an applicable mechanic's lien or similar statute against the real property upon which the Project is located.

8. **Improvements** The intent of this Bond shall be to include, without limitation, in the terms "Improvements" and "labor, materials, or equipment" that part of water, gas, power, light, heat, oil, gasoline, telephone service or rental equipment used in performing the Work, architectural, engineering, and consulting services required for the work of the Subcontractor and the Subcontractor's subcontractors, and all other items for which a mechanic's lien may be asserted.

9. **Principal Surety** Surety is the principal surety and its obligations under this Bond shall be deemed primary to any bond procured by Contractor, with Contractor's surety being deemed a sub-surety.

10. **Changes** Surety agrees that no change, extension of time, alteration, addition, deletion, amendment, or other modification of the Agreement or the Prime Contract between Contractor and the Project owner, or both, or in the Work, specifications, drawings, whether material or otherwise, or in the manner, time or amount of payment as provided therein, and whether or not made in the manner as provided therein, shall in any way affect Surety's obligations on this Bond, except that the Bond Sum shall increase directly with any additive amendments to the Agreement. Surety hereby waives notice of any changes, extensions of time, alterations, additions, deletions, amendments, and other modifications to the Agreement.

Subcontractor and Surety cause this Bond to be duly executed and acknowledged as set forth below, on this day of _____.

SUBCONTRACTOR
Company:

_____
By:
Its:

SURETY
Company:

_____
By:
Its: Attorney in Fact

(Impress Corporate Seal)

SUBCONTRACTOR PERFORMANCE BOND

BOND NUMBER: _____

SUBCONTRACTOR: _____
Address: _____
As Principal (the Principal), and

SURETY: (or Sureties) _____
Address: _____
Phone Number: _____
Email: _____
As Surety or Co-Sureties (collectively, Surety), and

CONTRACTOR: **THE CHRISTMAN COMPANY**
Address: 208 N. Capitol Avenue, Lansing, MI 48933
As Obligee (Obligee)

PROJECT: _____

SUBCONTRACT DATE: _____

CONTRACT AMOUNT: $ _____

BOND AMOUNT (Penal Sum): Dollars _____
($)

WHEREAS, Principal has by written agreement entered into a Subcontract Agreement or Purchase Order (Agreement) with Obligee in the amount stated above (Contract Amount) for the performance of work, including warranty obligations (Work), as detailed in the Agreement, which Agreement in its entirety is by reference expressly incorporated into this Bond.

WHEREAS, the amount of this Bond (Penal Sum) is in the amount stated above.

NOW THEREFORE, Principal and Surety are held and firmly bound to Obligee for the payment of the Penal Sum and agree to bind themselves and their respective heirs, administrators, executors, successors and permitted assigns, jointly and severally, firmly as follows:

1. If Principal shall promptly and faithfully perform the Agreement within the time provided therein, then this obligation shall be null and void; otherwise it shall remain in full force and effect.

2. Surety agrees that no change, extension of time, alteration, addition, deletion, amendment, or other modification of the Agreement or the Prime Contract between Obligee and the Project owner, or both, or in the Work, specifications, drawings, whether material or otherwise, or in the manner, time or amount of payment as provided therein, and whether or not made in the manner as provided therein, shall in any way affect Surety's obligations on this Bond, except that the Penal Sum of this Bond shall increase directly with any additive amendments to the Agreement provided the additive change(s) do not, either singly or in the aggregate, exceed 20% of the original Contract Amount. If any change singly or in the aggregate exceeds 20% of the original Contract Amount, Obligee shall obtain Surety's written consent to increase the Penal Sum. Surety hereby waives notice of any changes, extensions of time, alterations, additions, deletions, amendments, and other modifications to the Agreement.

3. Whenever Obligee has declared Principal to be in default of the Agreement, Surety shall, within twenty (20) calendar days of receipt of Obligee's declaration of default (Investigation Period), respond as follows, failure of

which shall be a material breach of this Bond:

a. Determine the amount for which Surety may be liable and tender the amount to Obligee; or,

b. Notify Obligee that Surety has elected to complete the Work itself or through its agents or contractors in accordance with the terms and conditions of the Agreement, in a manner acceptable to Obligee, and thereafter promptly begin the Work; or,

c. Obtain bids or offers from replacement subcontractors (Completing Subcontractor), reasonably acceptable to Obligee, to complete the Agreement in accordance with its terms and conditions, and upon determination by Surety and Obligee jointly of the lowest responsible bidder or offeror, arrange for new performance and payment bonds from the Completing Subcontractor in a form and from a surety as required by the Agreement, all of which must be completed before expiration of the Investigation Period. Upon execution of the agreement between Completing Contractor and Obligee, Surety shall pay to Obligee, within five (5) days of execution, the difference between the cost to complete the Work and the Contract Balance; or,

d. Arrange to provide financial and/or other assistance to the Principal (Financing) to assist the Principal with timely completion of the Agreement. This option is subject to Obligee's concurrence, which concurrence may be withheld in Obligee's sole discretion.

e. Having made an independent assessment of the facts and circumstances of Obligee's declaration of default, deny Surety's liability in whole or in part and provide a detailed explanation of the reasons for its denial, specifying amounts that are disputed and undisputed. Surety shall tender payment of any undisputed amount.

4. Surety may request an extension of up to twenty (20) calendar days (Extension Period) to respond as required by the Bond. Surety shall finance performance of the Work during the Extension Period on a schedule and in a manner acceptable to Obligee. Upon expiration of the Extension Period, Surety shall respond as outlined in paragraph 3.

5. Upon declaration that Principal is in default, Obligee shall have the right, but not the obligation, to immediately proceed to perform or correct the Work and take such other action pursuant to its rights under the Agreement to mitigate the damages caused by Principal's default (Mitigation Work). Obligee's overhead (both field and home office) and profit shall be included in the cost of the Mitigation Work at a markup of 20% to the actual labor, material, equipment, and subcontractor costs Obligee incurs. Obligee shall keep Surety reasonably informed of costs incurred for the Mitigation Work. Obligee shall be entitled to deduct the cost of the Mitigation Work from the Contract Balance. To the extent Obligee's cost of the Mitigation Work exceeds the Contract Balance, Surety shall, as the Work progresses, promptly and without deduction, reimburse Obligee for such shortage. Reimbursement by Surety shall reduce the Penal Sum by the amount of Surety's reimbursement to Obligee.

6. The term Contract Balance means the Contract Amount, as adjusted by any amendments to the Agreement issued before declaration of default, less the amount paid by Obligee to Principal or others in accordance with the Agreement, less amounts to which Obligee is entitled to a setoff under the Agreement, and less any other amounts for which the Principal or Surety is liable under the Bond or Agreement.

7. Surety shall be liable for:

a. Principal's responsibilities for correcting defective work, warranty work, latent defects, indemnity, and completion of the Work.

b. Legal, design professional and delay costs resulting or arising from Principal's default, or resulting or arising from the actions or failure to act of the Surety under paragraph 3 herein,

and liquidated damages, or if no liquidated damages are specified in the Agreement, and actual damages caused by delayed performance or non-performance of the Principal.

c. Principal's responsibilities for damages and set-offs in accordance with the Agreement.

8. If Surety elects to act under paragraph 3, Surety's liability is limited to Penal Sum, as adjusted pursuant to paragraph 2 above. Notwithstanding the foregoing, Surety shall reimburse Obligee for Obligee's reasonable attorney fees and costs, which shall not be credited against the Penal Sum, from disputes arising from this Bond.

9. Neither Surety's payments for Work performed before Obligee's declaration of default, nor Surety's payments to Claimants as defined in any payment bond issued by Surety as a companion payment bond to this Bond, shall be credited against the Penal Sum of this Bond.

10. All Information Obligee provides to Surety, whether before or after Surety issues the Bond, is provided by Obligee voluntarily as a matter of courtesy and is merely an expression of opinion. Furnishing such information is not a guaranty or warranty of the accuracy or correctness and no responsibility or liability is assumed by Obligee as a result of providing such information to Surety. Surety shall not rely on such information in any manner and waives and releases Obligee and Obligee's surety from any such claims.

11. Surety shall not be liable to Obligee for obligations of the Principal that are unrelated to the Agreement.

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

13. No right or action shall accrue on this Bond to or for the use of any person or corporation other than Obligee or its heirs, executors, administrators, assigns or successors.

Principal and Surety cause this Bond to be duly executed and acknowledged as set forth below, on this day of _____.

SUBCONTRACTOR AS PRINCIPAL	**SURETY**
Company:	Company:
_____	_____
By:	By:
Its:	Its: Attorney in Fact
	(Impress Corporate Seal)

AFFIDAVIT OF BIDDER

The undersigned, the owner or authorized officer of _____(the "Bidder), pursuant to the familial disclosure requirement provided in the _____(the "School District") advertisement for construction bids, hereby represent and warrant, except as provided below, that no familial relationships exist between the owner(s) or any employee of _____and any member of the Board of Education of the School District or the Superintendent of the School District.

List any Familial Relationships:

BIDDER:

_____

By: _____

Its: _____

STATE OF MICHIGAN)
)ss.
COUNTY OF _____)

This instrument was acknowledged before me on the _____ day of _____, 20___, by _____.

_____

, Notary Public

_____ County, Michigan

My Commission Expires: _____

Acting in the County of: _____

AFFIDAVIT OF BIDDER

The undersigned, the owner or authorized officer of _____(the "Bidder), pursuant to the familial disclosure requirement provided in the _____(the "School District") advertisement for construction bids, hereby represent and warrant, except as provided below, that no familial relationships exist between the owner(s) or any employee of C2AE Architects and or The Christman Company.

List any Familial Relationships:

BIDDER:

_____

By: _____

Its: _____

STATE OF MICHIGAN)
)ss.
COUNTY OF _____)

This instrument was acknowledged before me on the _____ day of _____, 20___, by _____.

_____

, Notary Public

_____ County, Michigan

My Commission Expires: _____

Acting in the County of: _____

NON-DISCRIMINATION IN EMPLOYMENT CERTIFICATION

Lansing School District
Certificate of Intent to Comply with
"NON-DISCRIMINATION IN EMPLOYMENT" POLICY

I have read Lansing School District's Policy #3310, including paragraph #13 and hereby state my intent to comply with the terms and conditions contained therein. Further I agree to furnish the Michigan Civil Rights Commission with such data and records concerning employment as may be requested by that agency in determining compliance with the policy.

Print or type name of Contact Person:

Signed: _____

_____

Title: _____

Company: _____

Date: _____

AFFIDAVIT OF BIDDER - NON-COLLUSION

Lansing School District
AFFIDAVIT OF BIDDER
SWORN STATEMENT
"Non-Collusion"

DATE: _____

The Bidder, by its officers and agents or representatives, present at the time of filing this bid, being duly sworn, on their oaths, say that neither they nor any of them, have in any way, directly or indirectly, entered into any arrangement or agreement with any other Bidder, whereby such affiant or affiants or either of them has paid or is to pay to such other Bidder any sum of money, or has given, or is to give, to such other Bidder anything of value whatever, or such affiant or affiants or either of them has not, directly or indirectly, entered into any arrangement or agreement with any other Bidder or Bidders, which tends to or does lessen or destroy free competition in the letting of the Contract sought for by the attached bids; that no inducement of any form or character other than that which appears upon the face of the bid, will be suggested, offered, paid or delivered to any person whomsoever to influence the acceptance of the said bid or awarding of the Contract, nor has this Bidder any agreement or understanding of any kind whatsoever, with any person whomsoever to pay, deliver to, or share with any other person in any way or manner, any of the proceeds of the Contract sought by this bid.

IN TESTIMONY WHEREOF, the Bidder (an authorized individual) has agrees to the above:

_____
(Company Name)

By: _____
(Authorized Signer)

_____
Print or type Name and Title of Signer

Address:_____

Notary Public:_____

Subscribed and sworn to before me on this _____ day of _____, 2016

County of:_____ My Commission expires: _____

Telephone number: _____

IRAN ECONOMIC SANCTIONS ACT CERTIFICATE

In accordance with the Iran Economic Sanctions Act, Michigan 2012 PA 517, effective April 1, 2013, (MCL 129.311, *et seq.*), (the "Act"), the undersigned certifies in support of its bid or proposal that it is not an Iran linked business as such is defined in the Act.

Contractor:_____

By:_____

Dated: _____

Name:_____

Title:_____

Act No. 517
Public Acts of 2012
Approved by the Governor
December 28, 2012
Filed with the Secretary of State
December 28, 2012
EFFECTIVE DATE: April 1, 2013

STATE OF MICHIGAN
96TH LEGISLATURE
REGULAR SESSION OF 2012

Introduced by Senators Kahn, Marleau, Brandenburg, Anderson, Green and Booher

ENROLLED SENATE BILL No. 1024

AN ACT to prohibit persons who have certain economic relationships with Iran from submitting bids on requests for proposals with this state, political subdivisions of this state, and other public entities; to require bidders for certain public contracts to submit certification of eligibility with the bid; to require reports; and to provide for sanctions for false certification.

The People of the State of Michigan enact:

Sec. 1. This act shall be known and may be cited as the "Iran economic sanctions act".

Sec. 2. As used in this act:

(a) "Energy sector of Iran" means activities to develop petroleum or natural gas resources or nuclear power in Iran.

(b) "Investment" means 1 or more of the following:

(*i*) A commitment or contribution of funds or property.

(*ii*) A loan or other extension of credit.

(*iii*) The entry into or renewal of a contract for goods or services.

(c) "Investment activity" means 1 or more of the following:

(*i*) A person who has an investment of $20,000,000.00 or more in the energy sector of Iran.

(*ii*) A financial institution that extends $20,000,000.00 or more in credit to another person, for 45 days or more, if that person will use the credit for investment in the energy sector of Iran.

(d) "Iran" means any agency or instrumentality of Iran.

(e) "Iran linked business" means either of the following:

(*i*) A person engaging in investment activities in the energy sector of Iran, including a person that provides oil or liquefied natural gas tankers or products used to construct or maintain pipelines used to transport oil or liquefied natural gas for the energy sector of Iran.

(*ii*) A financial institution that extends credit to another person, if that person will use the credit to engage in investment activities in the energy sector of Iran.

(f) "Person" means any of the following:

(*i*) An individual, corporation, company, limited liability company, business association, partnership, society, trust, or any other nongovernmental entity, organization, or group.

(*ii*) Any governmental entity or instrumentality of a government, including a multilateral development institution, as defined in section 1701(c)(3) of the international financial institutional act, 22 USC 262r(c)(3).

(*iii*) Any successor, subunit, parent company, or subsidiary of, or company under common ownership or control with, any entity described in subparagraph (*i*) or (*ii*).

(g) "Public entity" means this state or an agency or authority of this state, school district, community college district, intermediate school district, city, village, township, county, public authority, or public airport authority.

Sec. 3. (1) Beginning April 1, 2013, an Iran linked business is not eligible to submit a bid on a request for proposal with a public entity.

(2) Beginning April 1, 2013, a public entity shall require a person that submits a bid on a request for proposal with the public entity to certify that it is not an Iran linked business.

Sec. 4. If a public entity determines, using credible information available to the public, that a person has submitted a false certification under section 3(2), the public entity shall provide the person with written notice of its determination and of the intent not to enter into or renew a contract with the person. The notice shall include information on how to contest the determination and specify that the person may become eligible for a future contract with the public entity if the person ceases the activities that cause it to be an Iran linked business. The person shall have 90 days following receipt of the notice to respond in writing and to demonstrate that the determination of false certification was made in error. If a person does not make that demonstration within 90 days after receipt of the notice, the public entity may terminate any existing contract and shall report the name of the person to the attorney general together with information supporting the determination.

Sec. 5. The attorney general may bring a civil action against any person reported under section 4. If a civil action results in a finding that the person submitted a false certification, the person is responsible for a civil penalty of not more than $250,000.00 or 2 times the amount of the contract or proposed contract for which the false certification was made, whichever is greater, the cost of the public entity's investigation, and reasonable attorney fees, in addition to the fine. A person who submitted a false certification shall be ineligible to bid on a request for proposal for 3 years from the date the public entity determines that the person has submitted the false certification.

Sec. 6. The provisions of this act are effective only if Iran is a state sponsor of terror as defined under section 2 of the divestment from terror act, 2008 PA 234, MCL 129.292.

Enacting section 1. This act takes effect April 1, 2013.

This act is ordered to take immediate effect.

Carol Morey Viventi

Secretary of the Senate

Gary L. Randall

Clerk of the House of Representatives

LEGAL STATUS OF BIDDER

CERTIFICATION REGARDING DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS. The Vendor and/or Bidder certifies to the best of its knowledge and belief that it and its principals: Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency; Have not within a three-year period preceding this agreement been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of federal or state antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property; Are not presently indicted for or otherwise criminally or civilly charged by a government entity (Federal, State, or local) with commission of any of the offences enumerated above in this certification; and Have not within a three-year period preceding this agreement had one or more public transactions (Federal, State, or local) terminated for cause or default; is not now or has been, within a three-year period preceding this date, been listed on the Excluded Parties List System website (EPLS).

Vendor/contractor will notify the Lansing School District Purchasing Office immediately upon becoming suspended or debarred if there is any current or ongoing contract or agreement in place between the district and the vendor/contractor.

Firm Name: _____

Address: _____

Phone & E-mail: _____

Name, title and signature of individual duly authorized to execute contracts:

The Owner, Principal, or Corporate Office of the responding firm is also attesting that all the information provided within this response is true.

Name: _____

Title: _____

Signature: _____

A Corporation organized and existing under the laws of the State of ____

DATE: Monday, November 28, 2022

PROJECT: AC Installation Package - Averill & Lyons Elementary Schools

OWNER: Lansing School District

GENERAL CONDITIONS OF THE CONTRACT FOR CONSTRUCTION

Attached project specific version of AIA A201-2017 as modified. All references to the “Standard form of General Conditions” are hereinafter used in these specifications shall refer to the above documents.

END OF SECTION

AIA® Document A201® – 2017

General Conditions of the Contract for Construction

for the following PROJECT:
(Name and location or address)

2022 Bond Issue Construction as identified in the preliminary qualification of bonds application # SBL/33-020-4-K12-28-01, in accordance with the Owner-approved plans and specifications, all applicable laws, the Owner's fixed budget, and as otherwise approved by the Owner.

THE OWNER:
(Name, legal status and address)

Lansing School District
519 West Kalamazoo Street
Lansing, Michigan 48933
Telephone Number: (517) 755-1000

THE ARCHITECT:
(Name, legal status and address)

C2AE
106 West Allegan Street, Suite 500
Lansing, MI 48933

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

For guidance in modifying this document to include supplementary conditions, see AIA Document A503™, Guide for Supplementary Conditions.

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ARTICLE 1 GENERAL PROVISIONS

§ 1.1 Basic Definitions

§ 1.1.1 The Contract Documents

The Contract Documents are enumerated in the Agreement between the Owner and Contractor (hereinafter the Agreement) and consist of the Agreement, Conditions of the Contract (General, Supplementary and other Conditions), Drawings, Specifications, Addenda issued prior to execution of the Contract, other documents listed in the Agreement, and Modifications issued after execution of the Contract. A Modification is (1) a written amendment to the Contract signed by both parties, (2) a Change Order, (3) a Construction Change Directive, or (4) a written order for a minor change in the Work issued by the Architect. Unless specifically enumerated in the ~~Agreement,~~ Agreement in writing, the Contract Documents ~~do not~~ also include the advertisement or invitation to bid, Instructions to Bidders, sample forms, other information furnished by the Owner in anticipation of receiving bids or proposals, accepted portions of the Contractor's bid or proposal, ~~or~~ and portions of Addenda relating to bidding or proposal requirements. The Contractor's execution of the Owner/Contractor Agreement and the Architect's execution of the Owner/Architect Agreement shall constitute their respective acceptance of all provisions of the Drawings, Addenda, and all Contract Documents as of the revision applicable to the date of such signature.

§ 1.1.2 The Contract

The Contract Documents form the Contract for Construction. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior negotiations, representations, or agreements, either written or oral. The Contract may be amended or modified only by a Modification. The Contract Documents shall not be construed to create a contractual relationship of any kind (1) between the Contractor and the Architect or the Architect's consultants, (2) between the Owner and a Subcontractor or a Sub-subcontractor, (3) between the Owner and the Architect or the Architect's consultants, or (4) between any persons or entities other than the Owner and the Contractor. The Architect shall, however, be entitled to performance and enforcement of obligations under the Contract intended to facilitate the Contractor's performance of ~~the Architect's~~ its duties.

§ 1.1.3 The Work

The term "Work" means the construction and services required by the Contract Documents, whether completed or partially completed, and includes all other labor, materials, equipment, and services provided or to be provided by the Contractor to fulfill the Contractor's obligations. The Work may constitute the whole or a part of the Project.

§ 1.1.4 The Project

The Project is the total construction of which the Work performed under the Contract Documents may be the whole or a part and which may include construction by the Owner and by Separate Contractors.

§ 1.1.5 The Drawings

The Drawings are the graphic and pictorial portions of the Contract Documents showing the design, location and dimensions of the Work, generally including plans, elevations, sections, details, schedules, and diagrams.

§ 1.1.6 The Specifications

The Specifications are that portion of the Contract Documents consisting of the written requirements for materials, equipment, systems, standards and workmanship for the Work, and performance of related services.

§ 1.1.7 Instruments of Service

Instruments of Service are representations, in any medium of expression now known or later developed, of the tangible and intangible creative work performed by the Architect and the Architect's consultants under their respective professional services agreements. Instruments of Service may include, without limitation, studies, surveys, models, sketches, drawings, specifications, and other similar materials.

§ 1.1.8 Initial Decision Maker

The Initial Decision Maker is the person identified in the Agreement to render initial decisions or interpretations, as applicable, on Claims in accordance with Section 15.2. The Initial Decision Maker shall not show partiality to the Owner or Contractor and shall not be liable for results of interpretations or decisions rendered in good faith.

§ 1.1.9 The term "Product(s)" as used in the Contract Documents refers to the materials, systems and equipment provided by the Contractor for use in the work of the Project.

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§ 1.1.10 The terms "Warranty" and "Guarantee" as uscd in the Contract Documents shall have the same meaning and shall be defined as "legally enforceable assurance of satisfactory performance or quality of a product or Work," but in all events subject to the terms and qualifications of the Contract Documents.

§ 1.1.11 Where materials, systems and equipment items are referred to in the singular, such reference shall not serve to limit the quantity required. The Contractor shall furnish quantities as required by the Contract Documents to complete the Work.

§ 1.1.12 Unless specifically limited in the Contract, the words "furnish," "install," and "provide," or any combination thereof, mean to furnish and incorporate into the Work, including all necessary labor, materials, and equipment and other items required to perform the Work indicated.

§ 1.1.13 The Project Manual is a volume assembled for the Work which may include the bidding requirements, sample forms, Conditions of the Contract and Specifications.

§ 1.2 Correlation and Intent of the Contract Documents

§ 1.2.1 The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work by the Contractor. The Contract Documents are complementary, and what is required by one shall be as binding as if required by all; performance by the Contractor shall be required only to the extent consistent with the Contract Documents and reasonably inferable from them as being necessary to produce the indicated results. If the Drawings and Specifications conflict with each other regarding the quality or quantity of Work required, the better quality and/or the greater quantity shall govern, and shall be provided, unless instructions are otherwise furnished to the Contractor by the Architect in writing with the Owner's consent.

§ 1.2.1.1 The invalidity of any provision of the Contract Documents shall not invalidate the Contract or its remaining provisions. If it is determined that any provision of the Contract Documents violates any law, or is otherwise invalid or unenforceable, then that provision shall be revised to the extent necessary to make that provision legal and enforceable. In such case the Contract Documents shall be construed, to the fullest extent permitted by law, to give effect to the parties' intentions and purposes in executing the Contract.

§ 1.2.2 Organization of the Specifications into divisions, sections and articles, and arrangement of Drawings shall not control the Contractor in dividing the Work among Subcontractors or in establishing the extent of Work to be performed by any trade. Where responsibility for particular Work is required of the Contractor, the Contractor shall not be released from that responsibility by reason of the location of the Specification, Drawing, or other information that establishes the responsibility. Thus, for example, the Contractor shall be responsible for all Work required of it, even though that responsibility may be shown only in that portion of the Contract Documents typically pertaining to another contractor or trade.

§ 1.2.3 Unless otherwise stated in the Contract Documents, words that have well-known technical or construction industry meanings are used in the Contract Documents in accordance with such recognized meanings.

§ 1.2.4 If there should be a conflict between two or more of the Contract Documents, the following order of interpretation shall apply.

.1 Where requirements specifically set forth in the Agreement are in conflict with other Contract Documents, including, but not limited to, these General Conditions, the Agreement shall govern.

.2 In all other instances, the conflict shall be resolved by complying with the provision that is most favorable to the Owner, as determined in the Owner's sole discretion.

.3 When a duplicate of material or equipment occurs in the Drawings, the Specifications or other Contract Documents, each Contractor shall be deemed to have bid on the basis of each furnishing such material or equipment. The Owner will decide which Contractor shall furnish the same.

§ 1.2.4.1 Without limiting the applicability of Section 1.2.4, if there should be conflict or ambiguity within any single Contract Document (for example, these General Conditions, as modified), the conflict or ambiguity shall be resolved by complying with the provision that is most favorable to the Owner, as determined in the Owner's sole discretion.

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§ 1.2.5 It is the intent of the Contract Documents to accomplish a complete and workmanlike installation in which there shall be installed new products as specified, and workmanship shall be thoroughly first class, executed by competent and experienced workmen.

.1 Details of preparation, construction, installation, and finishing encompassed by the Contract Documents shall conform to the industry standards of the respective trades, and that workmanship and construction methods shall be of workmanlike quality so as to accomplish a neat and finished job, consistent with industry standards.

.2 Where specific recognized standards are mentioned in the Specifications, it shall be interpreted that such requirements shall be complied with.

§ 1.2.6 The Contractor acknowledges that there may be items of the Work that the Contractor is responsible to provide under the Contract Documents that are not drawn or specified in the design but are necessary for the proper execution and completion of the Work, and are consistent with, and reasonably inferable from, the Drawings and Specifications. Provided the necessary work or materials does not materially increase the cost of the Work, all such items shall be provided as part of the Work without delay in its progress and without any increase in the Contract Sum.

§ 1.3 Capitalization

Terms capitalized in these General Conditions include those that are (1) specifically defined, (2) the titles of numbered articles, or (3) the titles of other documents published by the American Institute of Architects.

§ 1.4 Interpretation

In the interest of brevity the Contract Documents frequently omit modifying words such as "all" and "any" and articles such as "the" and "an," but the fact that a modifier or an article is absent from one statement and appears in another is not intended to affect the interpretation of either statement.

§ 1.5 Ownership and Use of Drawings, Specifications, and Other Instruments of Service

§ 1.5.1 The Architect and the Architect's consultants shall be deemed the authors and owners of their respective Instruments of Service, including the Drawings and Specifications, and unless otherwise indicated in the Contract Documents or the Owner/Architect Agreement, the Architect and the respective consultants will retain all common law, statutory, and other reserved rights in their Instruments of Service, including copyrights. The Contractor, Subcontractors, Sub-subcontractors, and suppliers shall not own or claim a copyright in the Instruments of Service. Submittal or distribution to meet official regulatory requirements or for other purposes in connection with the Project is not to be construed as publication in derogation of the Architect's or Architect's consultants' reserved rights.

§ 1.5.2 The Contractor, Subcontractors, Sub-subcontractors, and suppliers are authorized to use and reproduce the Instruments of ~~Service provided to them,~~ Service, subject to any protocols established pursuant to ~~Sections 1.7 and 1.8,~~ Section 1.7, solely and exclusively for execution of the Work. All copies made under this authorization shall bear the copyright notice, if any, shown on the Instruments of Service. The Contractor, Subcontractors, Sub-subcontractors, and suppliers may not use the Instruments of Service on other projects or for additions to the Project outside the scope of the Work without the specific written consent of the Owner, Architect, and the Architect's consultants.

§ 1.5.3 The Drawings, Specifications, and other documents and all data used in compiling any tests, surveys, or inspections at the Project Site and the results therefrom, as well as all photographs, drawings, specifications, schedules, data processing output, computer-aided design/drafting (CADD) system disks/tapes, computations, studies, audits, reports, models and other items of like kind, and all intellectual property, prepared or created for or in connection with the Project and required by the Owner, the Contractor, or a third party, belong to the Owner. The Contractor may retain one record set. All copies of them, except Contractor's record set, shall be returned or suitably accounted for upon completion of the Work. They are for use solely with respect to the Project. The Contractor shall not, without the prior written consent of the Owner, use or permit anyone to use any Drawings, Specifications, or other documents prepared for or in connection with the Project, or any concepts or ideas developed in connection with the Project, for any purpose other than the Project. The Owner shall at all times have access to and control over the disposition of any Drawings, Specifications, and other documents pertaining to the Project.

§ 1.6 Notice

§ 1.6.1 Except as otherwise provided in Section 1.6.2, where the Contract Documents require one party to notify or give notice to the other party, such notice shall be provided in writing to ~~the designated~~ an appropriate representative of the party to whom the notice is addressed and shall be deemed to have been duly served if delivered in person, by

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registered or certified mail, by courier, or by electronic transmission if ~~a method for electronic transmission is set forth in the Agreement.~~an acknowledgment of receipt is received from the recipient or proof of receipt is otherwise established. The parties acknowledge that an appropriate representative of the Owner shall have authority only to the extent provided by the Owner's Board of Education.

§ 1.6.2 Notice of Claims as provided in Section 15.1.3 shall be provided in writing and shall be deemed to have been duly served only if delivered to ~~the designated~~ an appropriate representative of the party to whom the notice is addressed by certified or registered mail, or by courier providing proof of delivery. The parties acknowledge that an appropriate representative of the Owner shall have authority only to the extent provided by the Owner's Board of Education.

§ 1.7 Digital Data Use and Transmission

The parties ~~shall~~ may agree upon protocols governing the transmission and use of Instruments of Service or any other information or documentation in digital form. ~~The parties will use AIA Document E203™–2013, Building Information Modeling and Digital Data Exhibit, to establish the protocols for the development, use, transmission, and exchange of digital data.~~

~~§ 1.8 Building Information Models Use and Reliance~~

~~Any use of, or reliance on, all or a portion of a building information model without agreement to protocols governing the use of, and reliance on, the information contained in the model and without having those protocols set forth in AIA Document E203™–2013, Building Information Modeling and Digital Data Exhibit, and the requisite AIA Document G202™–2013, Project Building Information Modeling Protocol Form, shall be at the using or relying party's sole risk and without liability to the other party and its contractors or consultants, the authors of, or contributors to, the building information model, and each of their agents and employees.~~

ARTICLE 2 OWNER

§ 2.1 General

§ 2.1.1 The Owner is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Owner shall designate in writing a representative who shall have express authority to bind the Owner with respect to ~~all~~ matters requiring the Owner's approval or ~~authorization.~~ authorization subject to parameters of authority established by the Owner's Board of Education as provided in writing to Contractor. Benjamin Shuldiner or his designee shall serve as initial Owner representatives and shall be reasonably available to Contractor. Except as otherwise provided in Section 4.2.1, the Architect does not have such authority. The term "Owner" means the Owner or the Owner's authorized representative.

§ 2.1.2 ~~The Owner shall furnish to the Contractor, within fifteen days after receipt of a written request, information necessary and relevant for the Contractor to evaluate, give notice of, or enforce mechanic's lien rights. Such information shall include a correct statement of the record legal title to the property on which the Project is located, usually referred to as the site, and the Owner's interest therein.~~ **NOT USED.**

§ 2.2 Evidence of the Owner's Financial Arrangements

§ 2.2.1 Prior to commencement of the Work and upon written request by the Contractor, the Owner shall ~~furnish~~ furnish, as applicable, to the Contractor reasonable evidence that the Owner has made financial arrangements to fulfill the Owner's obligations under the Contract. The Contractor shall have no obligation to commence the Work until the Owner provides such evidence. If commencement of the Work is delayed under this Section 2.2.1, the Contract Time shall be extended ~~appropriately.~~ appropriately by a mutual agreement in writing by the Owner and Contractor.

§ 2.2.2 Following commencement of the Work and upon written request by the Contractor, the Owner shall furnish to the Contractor reasonable evidence that the Owner has made financial arrangements to fulfill the Owner's obligations under the Contract only if (1) the Owner fails to make payments to the Contractor as the Contract Documents require; (2) the Contractor identifies in writing a reasonable concern regarding the Owner's ability to make payment when due; or (3) a change in the Work materially changes the Contract Sum. If the Owner fails to provide such evidence, as required, within fourteen days of the Contractor's request, the Contractor may immediately stop the Work and, in that event, shall immediately notify the Owner that the Work has ~~stopped.~~ stopped and state with specificity why any evidence provided (or not provided) by the Owner is insufficient. However, if the request is made because a change in the Work materially changes the Contract Sum under (3) above, the Contractor may immediately stop only that portion of the Work affected by the change until reasonable evidence is provided. If the Work is stopped under this

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Section 2.2.2, the Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable costs of shutdown, delay and start-up, plus interest as provided in the Contract Documents. The parties' disagreement as to the appropriateness of payment for services performed shall not constitute the Owner's failure to make financial arrangements to fulfill the Owner's obligations under the Contract Documents.

§ 2.2.3 After the Owner furnishes evidence of financial arrangements under this Section 2.2, the Owner shall not materially vary such financial arrangements without prior notice to the Contractor.

§ 2.2.4 Where information is protected by law and/or the Owner has designated information furnished under this Section 2.2 as "confidential," the Contractor shall keep the information confidential and shall not disclose it to any other person. However, the Contractor may disclose such "confidential" information, after seven (7) days' notice to the Owner, where disclosure is required by law, including a subpoena or other form of compulsory legal process issued by a court or governmental entity, or by court or arbitrator(s) order. ~~The~~ To the extent permitted by law, the Contractor may also disclose such "confidential" information to its employees, consultants, sureties, Subcontractors and their employees, Sub-subcontractors, and others who need to know the content of such information solely and exclusively for the Project and who agree to maintain the confidentiality of such information.

§ 2.3 Information and Services Required of the Owner

§ 2.3.1 Except for permits and fees that are the responsibility of the Contractor under the Contract Documents, ~~including~~ including, but not limited to, those required under Section 3.7.1, the Owner shall secure and pay for necessary approvals, easements, assessments and charges required for construction, use or occupancy of permanent structures or for permanent changes in existing facilities.

§ 2.3.2 The Owner shall retain an architect lawfully licensed to practice architecture, or an entity lawfully practicing architecture, in the ~~jurisdiction where the Project is located.~~ State of Michigan. That person or entity is identified as the Architect in the Agreement and is referred to throughout the Contract Documents as if singular in number.

§ 2.3.3 If the employment of the Architect terminates, the Owner shall employ a successor ~~to whom the Contractor has no reasonable objection and~~ whose status under the Contract Documents shall be that of the Architect.

§ 2.3.4 The Owner shall furnish surveys describing physical characteristics, legal limitations and utility locations for the site of the Project, and a legal description of the site. ~~The~~ Taking into account the Contractor's experience and expertise, and exercise of professional caution, the Contractor shall be entitled to rely on the accuracy of information furnished by the Owner but shall exercise proper precautions relating to the safe performance of the Work. The Contractor shall not be entitled to additional compensation resulting from its failure to confirm the location of site utilities or existing structures.

§ 2.3.5 ~~The~~ Upon specific written request by the Contractor, the Owner shall furnish information or services required of the Owner by the Contract Documents with reasonable promptness. The Owner shall also furnish any other information or services under the Owner's control and relevant to the Contractor's performance of the Work with reasonable promptness after receiving the Contractor's written request for such information or services. Contracts with other Contractors alone shall not constitute sufficient Owner control for purposes of this Section.

§ 2.3.6 Unless otherwise provided in the Contract Documents, the Owner shall furnish to the Contractor one copy of the Contract Documents for purposes of making reproductions pursuant to Section 1.5.2.

§ 2.4 Owner's Right to Stop the Work

If the Contractor fails to correct Work that is not in accordance with the requirements of the Contract Documents as required by Section 12.2 or ~~repeatedly~~ fails to carry out Work in accordance with the Contract Documents, the Owner may issue a written order to the Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, the right of the Owner to stop the Work shall not give rise to a duty on the part of the Owner to exercise this right for the benefit of the Contractor or any other person or entity, except to the extent required by Section 6.1.3. This right shall be in addition to and not in limitation of the Owner's rights under any provision of the Contract Documents.

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§ 2.5 Owner's Right to Carry Out the Work

If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents and fails within a ~~ten-day~~ three business day period after receipt of notice from the Owner or the Owner's designee (including, for this purpose, the Architect) to commence and continue correction of such default or neglect with diligence and promptness, the Owner may, without prejudice to other remedies the Owner may have, ~~correct such default or neglect. Such action by the Owner and amounts charged to the Contractor are both subject to prior approval of the Architect and the Architect may,~~ including any claim against the Contractor's Performance Bond, correct such default or neglect. In the event the Contractor's default or neglect results in a threat to the safety of persons or property, the Contractor shall immediately commence and continue correction; otherwise, the Owner may undertake the same actions as permitted in the prior sentence. In such case, an appropriate Change Order shall be issued deducting from payments then or thereafter due the Contractor the reasonable cost of correcting such deficiencies, including Owner's expenses, including any and all legal expenses incurred to effectuate and enforce this provision, and compensation for the Architect's and/or other Contractor's additional services made necessary by such default, neglect, or failure. If the Contractor does not agree to a Change Order as described in the preceding sentence, the Owner may nevertheless withhold the reasonable cost of correcting such deficiencies and the expenses identified in the preceding sentence (including, but not limited to, all legal expenses incurred to effectuate and enforce this provision). Exercise of such rights shall in no way limit or jeopardize the Owner's right to any claim against the Performance Bond or Contractor. The Architect may also, pursuant to Section 9.5.1, withhold or nullify a Certificate for Payment in whole or in part, to the extent reasonably necessary to reimburse the Owner for the reasonable cost of correcting such deficiencies, including the aforementioned Owner's expenses and compensation for the Architect's additional services made necessary by such default, neglect, or failure. If current and future payments are not sufficient to cover such amounts, the Contractor shall pay the difference to the Owner. If the Contractor disagrees with the actions of the Owner or the Architect, or the amounts claimed as costs to the Owner, the Contractor may file a Claim pursuant to Article 15. In the event the Owner directs another entity to perform Work pursuant to this Section that otherwise is the obligation of the Contractor, including correction of safety violations, either at the Contractor's request or as a result of the Contractor's failure to perform such Work, the Owner may withhold any payments due Contractor to cover all costs for labor, material, and equipment plus that other entity's administrative, profit, and overhead costs. If payments then or thereafter due the Contractor are not sufficient to cover such amounts, the Contractor shall pay the difference to the Owner.

ARTICLE 3 CONTRACTOR

§ 3.1 General

§ 3.1.1 The Contractor is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Contractor shall be lawfully licensed, if required in the jurisdiction where the Project is located. The Contractor shall designate in writing a representative who shall have express authority to bind the Contractor with respect to all matters under this Contract. The term "Contractor" means the Contractor or the Contractor's authorized representative.

§ 3.1.2 The Contractor shall perform the Work in accordance with the Contract Documents.

§ 3.1.3 The Contractor shall not be relieved of its obligations to perform the Work in accordance with the Contract Documents either by activities or duties of the Architect in the Architect's administration of the Contract, or by tests, inspections or approvals required or performed by persons or entities other than the Contractor.

§ 3.1.4 These General Conditions refer to the relationship between the Owner and Contractor. As to the contract between the Contractor and its Subcontractors, the General Conditions shall be read as the Contractor having the position of the Owner and the Subcontractors having the position of the Contractor. The Subcontractors are bound to the Contractor just as the Contractor is bound to the Owner. The Subcontractor shall have all the rights, duties and obligations to the Contractor as the Contractor has rights, duties and obligations to the Owner. The Subcontractors shall agree to and accept the same responsibility to the Owner as the Contractor. In the event any failure of a Subcontractor or the Subcontractor's Subcontractor or supplier, at any tier, causes any type of defective Work, injury, loss or damage to the Owner, direct or indirect, the Contractor shall be jointly and severally liable to the Owner for such injury in addition to any responsibility or liability of the Subcontractor.

§ 3.2 Review of Contract Documents and Field Conditions by Contractor

§ 3.2.1 Execution of the Contract by the Contractor is a representation that the Contractor has visited the site, become generally familiar with local conditions under which the Work is to be performed, and correlated personal

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observations with requirements of the Contract Documents. The Contractor shall independently verify all information related to utilities prior to beginning the Work. The Contractor shall make careful investigation to establish the exact location of any such items indicated on the Drawings (e.g., locate via hand digging before excavating). The Contractor shall be responsible for all costs arising out of damage to such items or additional construction costs incurred because Contractor failed to verify said information.

§ 3.2.2 Because the Contract Documents are complementary, the Contractor shall, before starting each portion of the Work, carefully study and compare the various Contract Documents relative to that portion of the Work, as well as the information furnished by the Owner pursuant to Section 2.3.4, shall take field measurements of any existing conditions related to that portion of the Work, and shall observe any conditions at the site affecting it. These obligations are for the purpose of facilitating coordination and construction by the Contractor and are not for the purpose of discovering errors, omissions, or inconsistencies in the Contract Documents; however, the Contractor shall promptly report to the Architect any errors, inconsistencies or omissions discovered by or made known to the Contractor as a request for information in such form as the Architect may require. It is recognized that the Contractor's review is made in the Contractor's capacity as a contractor and not as a licensed design professional, unless otherwise specifically provided in the Contract Documents.

§ 3.2.3 The Contractor is not required to ascertain that the Contract Documents are in accordance with applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, but the Contractor shall promptly report to the Architect any nonconformity discovered by or made known to the Contractor as a request for information in such form as the Architect may ~~require.~~require, with a copy of same to be forwarded to the Owner.

§ 3.2.4 If the Contractor believes that additional cost or time is involved because of clarifications or instructions the Architect issues in response to the Contractor's notices or requests for information pursuant to Sections 3.2.2 or 3.2.3, the Contractor shall submit Claims as provided in Article 15. If the Contractor fails to perform the obligations of Sections 3.2.2 or 3.2.3, the Contractor shall pay such costs and damages to the ~~Owner, subject to Section 15.1.7,~~ Owner as would have been avoided if the Contractor had performed such obligations. If the Contractor performs those obligations, the Contractor shall not be liable to the Owner or Architect for damages resulting from errors, inconsistencies or omissions in the Contract Documents, for differences between field measurements or conditions and the Contract Documents, or for nonconformities of the Contract Documents to applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities.

§ 3.2.5 Prior to submitting its bid, the Contractor shall have studied and compared the Contract Documents and shall have reported to the Architect any discovered error, inconsistency or omission in the Contract Documents. It will be presumed that the Contract Sum includes the cost of correcting any such error, inconsistency or omission, which could have been discovered by the exercise of reasonable diligence. Unless the Contractor establishes that such error, inconsistency or omission could not have been discovered by the exercise of reasonable diligence, the Contractor and the bidding Subcontractor(s) will make such corrections without additional compensation so that the Work is fully functional.

§ 3.3 Supervision and Construction Procedures

§ 3.3.1 The Contractor shall supervise and direct the Work, using the Contractor's best skill and attention. The Contractor shall be solely responsible for, and have control over, construction means, methods, techniques, sequences, and procedures, and for coordinating all portions of the Work under the Contract. If the Contract Documents give specific instructions concerning construction means, methods, techniques, sequences, or procedures, the Contractor shall evaluate the jobsite safety thereof and shall be solely responsible for the jobsite safety of such means, methods, techniques, sequences, or procedures. If the Contractor determines that such means, methods, techniques, sequences or procedures may not be safe, the Contractor shall give timely notice to the Owner and Architect, and shall propose alternative means, methods, techniques, sequences, or procedures. The Architect shall evaluate the proposed alternative solely for conformance with the design intent for the completed construction. Unless the Architect objects to the Contractor's proposed alternative, the Contractor shall perform the Work using its alternative means, methods, techniques, sequences, or procedures. The Contractor shall immediately notify the Architect and Owner of delays of any other Contractors that could impact timely coordination and completion of the Work.

§ 3.3.2 The Contractor shall be responsible to the Owner for acts and omissions of the Contractor's employees, Subcontractors and their agents and employees, and other persons or entities performing portions of the Work for, or on behalf of, the Contractor or any of its Subcontractors.

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§ 3.3.3 The Contractor shall be responsible for inspection of portions of Work already performed to determine that such portions are in proper condition to receive subsequent Work. The Contractor shall be deemed to have accepted prior work when it commences provision of subsequent Work and shall be responsible for the cost of repair, replacement, or reconstruction if the prior work is found to be improper.

§ 3.4 Labor and Materials and Utilities

§ 3.4.1 Unless otherwise provided in the Contract Documents, the Contractor shall provide and pay for labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary for proper execution and completion of the Work, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work. Such provision of labor and materials shall occur in sufficient time to satisfy the existing Project schedule. The Contractor bears the risk of any failure to timely provide such labor and materials for any reason. The Contractor agrees to execute the appropriate UCC forms to effectuate the Owner's ownership of the material and equipment furnished pursuant to this Agreement.

§ 3.4.2 Except in the case of minor changes in the Work approved by the Architect in accordance with Section 3.12.8 or ordered by the Architect in accordance with Section 7.4, the Contractor may make substitutions only with the consent of the Owner, after evaluation by the Architect and in accordance with a Change Order or Construction Change Directive.

§ 3.4.3 The Contractor shall enforce strict discipline and good order among the Contractor's employees and other persons carrying out the Work. The Contractor shall not permit employment of unfit persons or persons not properly skilled in tasks assigned to them.

§ 3.4.4 The Contractor agrees that neither it nor its Subcontractors will discriminate against any employee or applicant for employment, to be employed in the performance of this Contract, with respect to hire, tenure conditions or privilege of employment, or any matter directly or indirectly related to employment, because of race, age, sex, color, religion, national origin, ancestry or physical disability. Breach of this covenant may be regarded as a material breach of this Contract.

§ 3.4.5 Immediately after "award of the Contract," the Contractor shall provide the Architect a list showing the name of the manufacturer proposed to be used for each of the product(s) identified in the Specifications and, where applicable, the name of the installing Subcontractor.

§ 3.4.6 The Architect will reply in writing to the Contractor stating whether the Owner or the Architect, after due investigation, has reasonable objection to any such proposal. If adequate data on any proposed manufacturer or installer is not available, the Architect may state that action will be deferred until the Contractor provides further data.

§ 3.4.7 In all cases involving utilities, unless the Contract Documents specifically provide otherwise, it shall be the Contractor's responsibility to coordinate the Work with the owners of such utilities for the protection of such utilities and for the safety associated with working with or in the vicinity of such utilities. The Contractor shall coordinate any work required by private and/or public utility companies to provide utilities to the Work and/or shall coordinate relocation of utilities as required by the Work. Any reference to the Owner being responsible for the coordination of, the paying for, or the relocation of any utility or associated equipment, which it does not own or control, requires only reasonable efforts by the Owner to coordinate such activity.

§ 3.4.8 Asbestos-Free Product Installation

§ 3.4.8.1 It is hereby understood and agreed that no product and/or material containing asbestos, including chrysolite, amosite, crocidolite, tremolite asbestos, anthorphyllite asbestos, actinolite asbestos and any combination of these materials that have been chemically treated and/or altered shall be installed or introduced into the Work by the Contractor or its employees, agents, Subcontractors, or other individuals or entities over whom the Contractor has control. The Contractor shall be required to provide a signed certification statement ensuring that all products or materials installed or introduced into the Work will be asbestos-free.

§ 3.4.8.2 The Contractor also shall be required to furnish certified statements from the manufacturers of supplied materials used during construction verifying their products to be asbestos-free in accordance with the requirements of Section 3.4.8.1.

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§ 3.4.8.3 The Contractor shall complete and submit to the Owner a certification evidencing asbestos-free product installation prior to issuance of the final Certificate for Payment in a form acceptable to the Owner.

§ 3.4.9 Asbestos may be present within the construction areas. Contractors are to become aware of Owner's hazardous material report prior to construction. Work is not to disturb any in-place hazardous materials. The Contractor must immediately stop all Work and notify the Owner if it reasonably suspects the presence of unknown hazardous materials and/or has disturbed any materials reasonably suspected to be hazardous materials.

§ 3.5 Warranty

§ 3.5.1 ~~The Contractor warrants to the Owner and Architect that materials and equipment furnished under the Contract will be of good quality and new unless the Contract Documents require or permit otherwise. The Contractor further warrants that the Work will conform to the requirements of the Contract Documents and will be free from defects, except for those inherent in the quality of the Work the Contract Documents require or permit. Work, materials, or equipment not conforming to these requirements may be considered defective.~~ In addition to any other warranties, guarantees, or obligations set forth in the Contract Documents or applicable as a matter of law, and not in limitation of the terms of the Contract Documents, the Contractor warrants and guarantees that:

.1 The Owner will have good title to the Work and all materials and equipment incorporated into the Work and, unless otherwise expressly provided in the Contract Documents, will be new.

.2 The Work and all materials and equipment incorporated into the Work will be free from all defects, including any defects in workmanship or materials.

.3 The Work and all materials and equipment incorporated into the Work will be merchantable at the time of installation.

.4 The Work and all materials and equipment incorporated into the Work will conform in all respects to the Contract Documents in the reasonable judgment of Architect.

The Contractor's warranty excludes remedy for damage or defect caused by abuse, alterations to the Work not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear and normal usage. ~~If required by the Architect, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.~~

Upon notice of the breach of any of the foregoing warranties or guarantees or any other warranties or guarantees under the Contract Documents, the Contractor, in addition to any other requirements in the Contract Documents, will commence to correct such breach within 72 hours after written notice thereof and thereafter will use its commercially reasonable best efforts to correct such breach to the satisfaction of the Owner; provided that if such notice is given after final payment hereunder, such 72 hour period shall be extended to seven (7) days. The foregoing warranties and obligations of the Contractor shall survive the final payment and/or termination of the Contract.

The Contractor shall, at the time of final completion of the Work and as a condition precedent to final payment to the Contractor, assign to the Owner all manufacturers' warranties related to the materials and labor used in the Work. The Contractor further agrees to perform the Work in such manner as to preserve any and all such manufacturers' warranties and deliver to the Architect the warranties, project manuals, operating procedures, and other materials related to each of the building systems and materials included in the Contractor's Work and as required by the Specifications.

Notwithstanding anything contrary in the foregoing or in any other Contract Document(s), labor shall be warranted for one year, commencing as of the date specified in the Architect's Certificate of Substantial Completion, and the manufacturer warranties applicable to the materials integrated into the Work shall commence and end as provided in the such warranty documents, provided to Owner in accordance with this Section 3.5.1.

§ 3.5.2 All material, equipment, or other special warranties required by the Contract Documents shall be issued in the name of the Owner, or shall be transferable to the Owner, and shall commence in accordance with Section 9.8.4.

§ 3.6 Taxes

The Contractor shall pay sales, consumer, use and similar taxes for the Work provided by the Contractor that are legally enacted when bids are received or negotiations concluded, whether or not yet effective or merely scheduled to go into effect. The Contractor shall pay all local, state and federal taxes levied on its business, income or property and

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shall make all contributions for social security and other wage or payroll taxes. The Contractor shall be solely responsible for such payments and shall indemnify the Owner and hold it harmless from same.

§ 3.7 Permits, Fees, Notices and Compliance with Laws

§ 3.7.1 ~~Unless otherwise provided in the Contract Documents, the~~ The Contractor shall secure and pay for the building permit as well as for other permits, fees, licenses, and inspections by government agencies necessary for proper execution and completion of the Work that are customarily secured after execution of the Contract and legally required at the time bids are received or negotiations concluded.

§ 3.7.2 The Contractor shall comply with and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities applicable to performance of the Work.

§ 3.7.3 If the Contractor performs Work ~~knowing it to be~~ contrary to applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, the Contractor shall assume appropriate responsibility for such Work and shall bear the costs attributable to correction.

§ 3.7.4 Concealed or Unknown Conditions

If the Contractor encounters conditions at the site that are (1) subsurface or otherwise concealed physical conditions that differ materially from those indicated in the Contract Documents or (2) unknown physical conditions of an unusual nature that differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents, the Contractor shall promptly provide written and dated notice to the Owner and the Architect before conditions are disturbed and in no event later than 14 days after first observance of the conditions. The Architect will promptly investigate such conditions and, if the Owner and Architect determines that they differ materially and cause an increase or decrease in the Contractor's cost of, or time required for, performance of any part of the Work, they will recommend that an equitable adjustment be made in the Contract Sum or Contract Time, or both. If the ~~Architect determines~~ Owner and Architect determine that the conditions at the site are not materially different from those indicated in the Contract Documents and that no change in the terms of the Contract is justified, the Architect shall promptly notify the ~~Owner and Contractor,~~ Contractor in writing, stating the reasons. If ~~either party~~ Contractor disputes the ~~Architect's~~ determination or recommendation, ~~that party may~~ the Contractor shall submit a Claim as provided in Article 15. The requirements of Section 2 of 1998 PA 57, as amended, are hereby incorporated into this document. The Contractor shall be alert to any indication or evidence of existing underground or concealed utilities or structures not shown on the Contract Documents and shall immediately notify the Owner of discovery of such evidence. If the Contractor encounters such utilities or structures, it shall cease operations immediately to minimize damage and shall notify the Owner and Architect. The Contractor shall bear the cost of damage resulting from its failure to exercise reasonable care in its construction activity or from continuing operations without notifying the Owner.

§ 3.7.4.1 The Contractor bidding on the Work is responsible for visiting the site and determining all local conditions, except those that are hidden or unknown, that may in any way affect its Work.

§ 3.7.5 If, in the course of the Work, the Contractor encounters human remains or recognizes the existence of burial markers, archaeological sites or wetlands not indicated in the Contract Documents, the Contractor shall immediately suspend any operations that would affect them and shall ~~notify~~ provide written and dated notification to the Owner and Architect. Upon receipt of such notice, the Owner shall promptly take any action necessary to obtain governmental authorization required to resume the operations. The Contractor shall continue to suspend such operations until otherwise instructed by the Owner but shall continue with all other operations that do not affect those remains or features. Requests for adjustments in the Contract Sum and Contract Time arising from the existence of such remains or features ~~may be made~~ shall be made, as needed, as provided in Article 15.

§ 3.8 Allowances

§ 3.8.1 The Contractor shall include in the Contract Sum all allowances stated in the Contract Documents. Items covered by allowances shall be supplied for such amounts and by such persons or entities as the Owner may direct, but the Contractor shall not be required to employ persons or entities to whom the Contractor has reasonable objection.

§ 3.8.2 Unless otherwise provided in the Contract Documents,

.1 allowances shall cover the cost to the Contractor of materials and equipment delivered at the site and all required taxes, less applicable trade discounts;

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.2 Contractor's costs for unloading and handling at the site, labor, installation costs, overhead, profit, and other expenses contemplated for stated allowance amounts shall be included in the Contract Sum but not in the allowances; and

.3 whenever costs ~~are more than or less than~~ differ from allowances, the Contract Sum ~~shall~~ may be adjusted accordingly by Change Order. The amount of the Change Order shall reflect (1) the difference between actual costs and the allowances under Section 3.8.2.1 and (2) changes in Contractor's costs under Section 3.8.2.2.

§ 3.8.3 Materials and equipment under an allowance shall be selected by the Owner with reasonable promptness.

§ 3.9 Superintendent

§ 3.9.1 The Contractor shall employ a competent superintendent and necessary assistants who shall be in attendance at the Project site during performance of the Work. The superintendent shall represent the Contractor, and communications given to the superintendent shall be as binding as if given to the Contractor. The superintendent shall be satisfactory to the Owner in all respects, and the Owner shall have the right to require the Contractor to remove any superintendent from the Project whose performance is not satisfactory to the Owner and to replace such superintendent with a superintendent who is satisfactory to the Owner.

§ 3.9.2 The Contractor, as soon as practicable after award of the Contract, shall notify the Owner and Architect of the name and qualifications of a proposed superintendent. Within 14 days of receipt of the information, the Owner and/or the Architect may notify the Contractor, stating whether the Owner ~~or~~ and/or the Architect (1) has reasonable objection to the proposed superintendent or (2) requires additional time for review. ~~Failure of the Architect to provide notice within the 14-day period shall constitute notice of no reasonable objection.~~

§ 3.9.3 The Contractor shall not employ a proposed superintendent to whom the Owner or Architect has made reasonable and timely objection. The Contractor shall not change the superintendent without the Owner's ~~consent, which shall not unreasonably be withheld or delayed.~~consent .

§ 3.10 Contractor's Construction and Submittal Schedules

§ 3.10.1 The Contractor, promptly after being awarded the Contract, shall prepare and submit for the Owner's and Architect's information a Contractor's construction schedule for the Work. The schedule shall contain detail appropriate for the Project, including (1) the date of commencement of the Work, interim schedule milestone dates, and the date of Substantial Completion; (2) an apportionment of the Work by construction activity; and (3) the time required for completion of each portion of the Work. The schedule shall provide for the orderly progression of the Work to completion and shall not exceed time limits ~~current under the Contract Documents.~~ required under the Contract Documents or any scheduling updates issued by the Architect or Owner. The schedule shall be revised at appropriate intervals as required by the conditions of the Work and Project. In no event shall the Contractor's Construction Schedule be extended due to action or inaction of the Contractor, except with prior written approval of the Owner within the Owner's sole discretion.

The Contractor shall cooperate with the Architect and Owner in scheduling and performing the Contractor's Work to avoid conflict with, and as to cause no delay in, the work or activities of other contractors or the construction or operations of the Owner's own forces. The Contractor acknowledges and understands that the work schedule will be modified from time-to-time with the Owner's approval to coordinate with the work of others and that such schedule changes do not give rise to a claim for damages or additional compensation by the Contractor for delay or otherwise. The Contractor shall be required to conform to the most recent Owner-approved schedule and acknowledges that fact was taken into account when it agreed to the Contract Sum and entered into this Contract.

§ 3.10.2 The Contractor, promptly after being awarded the Contract and thereafter as necessary to maintain a current submittal schedule, shall submit a submittal schedule for the ~~Architect's approval. The Architect's approval~~ Owner's and Architect's approval. The Owner's and the Architect's approvals shall not be unreasonably delayed or withheld. The submittal schedule shall (1) be coordinated with the Contractor's construction schedule, ~~and (2) allow the Architect reasonable time to review submittals.~~ (2) allow for a reasonable amount of time to review submittals, and (3) shall provide for expeditious and practical execution of the Work. If the Contractor fails to submit a submittal schedule, or fails to provide submittals in accordance with the approved submittal schedule, the Contractor shall not be entitled to any increase in Contract Sum or extension of Contract Time based on the time required for review of submittals.

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§ 3.10.3 The Contractor shall perform the Work in general accordance with the most recent ~~schedules submitted to the Owner and Architect.~~approved Project schedules and the most recent Work schedule submitted to the Owner and Architect consistent therewith.

§ 3.10.4 Progress Meetings: Meetings of representatives of the various Contractors may be held for the purpose of coordination and furthering the progress of the Work. Contractor and Subcontractor attendance is mandatory. Meetings shall be held at regular intervals as provided in the General Requirements; special meetings may be held if deemed necessary by the Owner and/or Architect.

§ 3.10.5 The Contractor shall proceed strictly (not substantially) in accordance with the critical path set forth in the Construction Schedule. The Contractor shall monitor the progress of the Work for conformance with the requirements of the Construction Schedule and shall promptly advise the Owner of any delays or potential delays. If any progress report indicates any delays, the Architect shall propose an affirmative plan to correct the delay, including overtime and/or additional labor, if necessary. In no event shall any progress report constitute an adjustment of the Contract Time or any Milestone Date or the Contract Sum unless any such adjustment is agreed to by the Owner and authorized pursuant to a Change Order.

§ 3.11 Documents and Samples at the Site

The Contractor shall make available, at the Project site, the Contract Documents, including Change Orders, Construction Change Directives, and other Modifications, in good order and marked currently to indicate field changes and selections made during construction, and the approved Shop Drawings, Product Data, Samples, and similar required submittals. These shall be in electronic form or paper copy, available to the Architect and Owner, and delivered to the Architect for submittal to the Owner upon completion of the Work as a record of the Work as constructed.

§ 3.12 Shop Drawings, Product Data and Samples

§ 3.12.1 Shop Drawings are drawings, diagrams, schedules, and other data specially prepared for the Work by the Contractor or a Subcontractor, Sub-subcontractor, manufacturer, supplier, or distributor for submittal to and review by the Architect to illustrate some portion of the Work.

§ 3.12.2 Product Data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams, and other information furnished by the Contractor for submittal to and review by the Architect to illustrate materials or equipment for some portion of the Work. All Work shall be furnished and installed in accordance with the Drawings, Specifications, and as additionally required by the manufacturer's printed instructions. The Contractor shall review the manufacturer's instructions, and where conflict occurs between the Drawings or Specifications and the manufacturer's instructions, the Contractor shall request clarification from the Architect prior to commencing the Work.

§ 3.12.3 Samples are physical examples for submittal to and review by the Architect that illustrate materials, equipment, or workmanship, and establish standards by which the Work will be judged.

§ 3.12.4 Shop Drawings, Product Data, Samples, and similar submittals are not Contract Documents. Their purpose is to demonstrate how the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents for those portions of the Work for which the Contract Documents require submittals. Review by the Architect is subject to the limitations of Section 4.2.7. Informational submittals upon which the Architect is not expected to take responsive action may be so identified in the Contract Documents. Submittals that are not required by the Contract Documents may be returned by the Architect without action.

§ 3.12.5 The Contractor shall review for compliance with the Contract Documents, approve, and submit to the Architect, Shop Drawings, Product Data, Samples, and similar submittals required by the Contract Documents, in accordance with the submittal schedule approved by the Architect or, in the absence of an approved submittal schedule, with reasonable promptness and in such sequence as to cause no delay in the Work or in the activities of the Owner or of Separate Contractors.

The Contractor agrees to ensure that its first submissions shall comply with all the requirements of the Contract Documents. It is further agreed that if any Shop Drawing, Project Data, Sample, or similar submittals require excessive submissions to secure the approval of the Architect due to the Contractor's failure to comply with specified

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products, resulting in delays or excessive reviews by the Architect, the Contractor will be held responsible for delays, added review costs, and damages to the Owner caused by such delays. Without limiting the foregoing, the Contractor's obligation to hold the Owner harmless from and bear the costs for any delay, good faith rejection of or resulting from any Shop Drawing, Project Data, Sample or similar submittal by Architect provided such delay or rejection is conditioned on such delay or rejection being attributable to a negligent act or omission of Contractor.

§ 3.12.6 By submitting Shop Drawings, Product Data, Samples, and similar submittals, the Contractor represents to the Owner and Architect that the Contractor has (1) reviewed and approved them, (2) determined and verified materials, field measurements and field construction criteria related thereto, or will do so, and (3) checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents.

§ 3.12.7 The Contractor shall perform no portion of the Work for which the Contract Documents require submittal and review of Shop Drawings, Product Data, Samples, or similar submittals, until the respective submittal has been approved by the Architect.

§ 3.12.8 The Work shall be in accordance with approved submittals except that the Contractor shall not be relieved of responsibility for deviations from the requirements of the Contract Documents by the Architect's review and approval of Shop Drawings, Product Data, Samples, or similar submittals, unless the Contractor has specifically notified the Architect in detailed writing of such deviation at the time of submittal and (1) the Architect has given written approval to the specific deviation as a minor change in the Work, or (2) a Change Order or Construction Change Directive has been issued authorizing the deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples, or similar submittals, by the Architect's approval thereof.

§ 3.12.9 The Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, Product Data, Samples, or similar submittals, to revisions other than those requested by the Architect on previous submittals. In the absence of such notice, the Architect's approval of a resubmission shall not apply to such revisions.

§ 3.12.10 The Contractor shall not be required to provide professional services that constitute the practice of architecture or engineering unless such services are specifically required by the Contract Documents for a portion of the Work or unless the Contractor needs to provide such services in order to carry out the Contractor's responsibilities for construction means, methods, techniques, sequences, and procedures. The Contractor shall not be required to provide professional services in violation of applicable law.

§ 3.12.10.1 If professional design services or certifications by a design professional related to systems, materials, or equipment are specifically required of the Contractor by the Contract Documents, the Owner and the Architect will specify all performance and design criteria that such services must satisfy. ~~The~~ Subject to its professional skill and expertise, the Contractor shall be entitled to rely upon the adequacy and accuracy of the performance and design criteria provided in the Contract Documents. The Contractor shall cause such services or certifications to be provided by an appropriately licensed design professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings, and other submittals prepared by such professional. Shop Drawings, and other submittals related to the Work, designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to the Architect. The Owner and the Architect shall be entitled to rely upon the adequacy and accuracy of the services, certifications, and approvals performed or provided by such design professionals, provided the Owner and Architect have specified to the Contractor the performance and design criteria that such services must satisfy. Pursuant to this Section 3.12.10, the Architect will review and approve or take other appropriate action on submittals only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents.

§ 3.12.10.2 If the Contract Documents require the Contractor's design professional to certify that the Work has been performed in accordance with the design criteria, the Contractor shall furnish such certifications to the Architect at the time and in the form specified by the Architect.

§ 3.13 Use of Site

~~The Contractor shall confine operations at the site to areas permitted by applicable laws, statutes, ordinances, codes, rules and regulations, lawful orders of public authorities, and the Contract Documents and shall not unreasonably encumber the site with materials or equipment.~~ **§ 3.13.1** The Contractor shall confine operations at the site to areas

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permitted by applicable laws, statutes, ordinances, codes, rules and regulations, lawful orders of public authorities, and the Contract Documents and shall not unreasonably encumber the site with materials or equipment.

§ 3.13.2 Anything contained in the Contract Documents to the contrary notwithstanding, no one except the Owner shall be permitted to disrupt the operation of any building system or any other services without the Owner's prior written consent. Any request to perform such work shall be in writing, received by the Owner no less than five (5) days prior to the commencement of the requested disruption, and shall detail (1) the exact nature and duration of such interruption, (ii) the area affected, and (iii) any impact upon the Construction Schedule caused by such proposed temporary disruption. Unless otherwise approved by the Owner, all work shall be performed during the hours and on the days set forth in the Specifications, in accordance with the most-recent project schedule, and/or as directed by the Owner or Architect. The Contractor's failure to comply with the notice provisions of this section shall constitute a waiver by the Contractor of any right it may have to an adjustment of the Contract Time, on account of any postponement, rescheduling, or other delays ordered by the Owner in connection with any Work for which appropriate notice was not furnished.

§ 3.13.3 The Contractor will consult with the Owner and the Architect concerning any necessary operations at the Project site, including staging area limits, office or storage trailer locations, dumpster operations, equipment and material deliveries, hoisting areas and any other construction impacts on the Owner's grounds.

§ 3.14 Cutting and Patching

§ 3.14.1 The Contractor shall be responsible for cutting, fitting, or patching required to complete the Work or to make its parts fit together properly. All areas requiring cutting, fitting, or patching shall be restored to the condition existing prior to the cutting, fitting, or patching, unless otherwise required by the Contract Documents.

§ 3.14.2 The Contractor shall not damage or endanger a portion of the Work or fully or partially completed construction of the Owner or Separate Contractors by cutting, patching, or otherwise altering such construction, or by excavation. The Contractor shall not cut or otherwise alter construction by the Owner or a Separate Contractor except with written consent of the Owner and of the Separate Contractor. Consent shall not be unreasonably withheld. The Contractor shall not unreasonably withhold, from the Owner or a Separate Contractor, its consent to cutting or otherwise altering the Work.

§ 3.15 Cleaning Up

§ 3.15.1 The Contractor and its Subcontractors, under the Contractor's direction, shall keep the premises and surrounding area free from accumulation of waste materials and rubbish caused by operations under the Contract. At completion of the Work, the Contractor shall remove waste materials, rubbish, the Contractor's tools, construction equipment, machinery, and surplus materials from and about the Project.

§ 3.15.2 If the Contractor fails to clean up as provided in the Contract Documents, the Owner may do so and the Owner shall be entitled to reimbursement from the Contractor.

§ 3.15.3 Any areas and/or concurrently occupied space both occupied by the Owner and used in the progress of the Work, both within the limits of the construction site and the adjacent areas leading to it, shall be maintained, opened to travel and kept in a clean condition. Failure by the Contractor to maintain said areas will result in the Owner's cleaning of same, at the expense of the Contractor.

§ 3.15.4 In addition to removal of rubbish, the Contractor and its Subcontractors, under the Contractor's direction, shall replace any broken glass, remove stains, spots, marks, and dirt from decorated work, clean hardware, and/or remove spots and smears from all surfaces which were affected by the Work.

§ 3.16 Access to Work

The Contractor shall provide the Owner and Architect with access to the Work in preparation and progress wherever located.

§ 3.17 Royalties, Patents and Copyrights

The Contractor shall pay all royalties and license fees. The Contractor shall defend suits or claims for infringement of copyrights and patent rights and shall indemnify and hold harmless the Owner and Architect ~~harmless from~~ from any and all cost, damages, or loss on account thereof, including, but not limited to, actual attorneys' fees, but shall not be

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responsible for defense or loss when a particular design, process, or product of a particular manufacturer or manufacturers is required by the Contract Documents, or where the copyright violations are contained in Drawings, Specifications, or other documents prepared by the Owner or Architect. However, if an infringement of a copyright or patent is discovered by, or made known to, the Contractor, the Contractor shall be responsible for the loss unless the information is promptly furnished to the Architect. The review by the Owner or Architect of any method of construction, invention, appliance, process, article, device or materials of any kind shall be for its adequacy in the Work and shall not be an approval for the use thereof by the Contractor in violation of any patent or other rights of any third person.

§ 3.18 Indemnification

§ 3.18.1 To the fullest extent permitted by law, the Contractor shall indemnify and hold harmless the Owner, the Owner's Board of Education, its board members, administration, its successors, assigns, Architect, Architect's consultants, and agents and employees of any of them (the "Indemnitees") from and against any and all claims, costs, damages, losses, liabilities, and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the ~~Work, provided that such claim, damage, loss, or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the~~ Work ~~itself), but only~~ to the extent caused in whole or in part by (i) the negligent acts or omissions of the Contractor, ~~a Subcontractor, anyone directly or indirectly employed by them, or anyone for whose acts they may be liable, regardless of whether or not such claim, damage, loss, or expense is caused in part by a party indemnified hereunder.~~ its officers, directors and employees, agents or subcontractors; (ii) any breach of the terms of the Contract Documents by the Contractor; or (iii) any breach of any representation or warranty by the Contractor under the Contract Documents. The Contractor shall notify the Owner by certified mail, return receipt requested, immediately upon knowledge of any claim, suit, action, or proceeding for which the Owner or one or more of the Indemnitees may be entitled to indemnification under the Contract Documents. Further, the Owner shall be entitled to recover attorneys' fees and legal fees from the Contractor under the following eireumstances: (1) the Owner has to defend a third-party claim or action for which the Contractor must indemnify the Owner as described above; and (2) the Owner successfully asserts a claim or action against the Contractor for professional negligence, breach of contract, and/or defective Work. For purposes of the previous sentence "successfully" means the Owner recovers damages from the Contractor, regardless of amount. The Contractor shall not be responsible for indemnifying an Indemnitee for the Indemnitee's negligence, but shall remain responsible to the fullest degree of Contractor's fault, on a comparative basis. Such obligation shall not be construed to negate, abridge, or reduce other rights or obligations of indemnity that would otherwise exist as to a party or person described in this Section 3.18.

§ 3.18.2 In ~~claims against any person or entity indemnified under this Section 3.18 by an employee of the Contractor, a Subcontractor, anyone directly or indirectly employed by them, or anyone for whose acts they may be liable, the indemnification obligation under Section 3.18.1 shall not be limited by a limitation on amount or type of damages, compensation, or benefits payable by or for the Contractor or a Subcontractor under workers' compensation acts, disability benefit acts, or other employee benefit acts.~~addition to and not in limitation of the Contractor's other indemnity obligations, the Contractor hereby accepts and assumes exclusive liability for and shall indemnify, protect, and hold harmless the Owner and Architect from and against the payment of the following:

.1 all contributions, taxes, or premiums (including interest and penalties thereof) which may be payable under the unemployment insurance law of any state, the federal Social Security Act, federal, state, county, and/or municipal tax withholding laws, or any other law, measured upon the payroll of or required to be withheld from employees by whomsoever employed, engaged in the Work to be performed and furnished under this Contract;

.2 all sales, use, personal property and other taxes (including interest and penalties thereof) required by any federal, state, county, municipal, or other law to be paid or collected by the Contractor or any of its Subcontractors or vendors or any other person or persons acting for, through or under it or any of them, by reason of the performance of the Work or the acquisition, ownership, furnishing, or use of any materials, equipment, supplies, labor, services, or other items for or in connection with the Work; and

.3 all pension, welfare, vacation, annuity, and other benefit contributions payable under or in connection with respect to all persons by whomsoever employed, engaged in the Work to be performed and furnished under this Contract.

Provided Owner or Architect has, in good faith and to the best of their knowledge, provided Contractor with complete, accurate, reports identifying the presence of any and all hazardous materials on Site as of the date of commencement of the Work, Contractor shall indemnify, defend, and hold the Owner harmless from any claim, damage, loss or

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expense, including, but not limited to, actual attorney fees, incurred by the Owner related to any hazardous material, condition or waste, toxic substance, pollution, or contamination brought into the Project site or caused or exacerbated by the Contractor or used, handled, transported, stored, removed, remediated, disturbed, or dispersed of by Contractor.

§ 3.18.3 In the event that any claim is made or asserted, or lawsuit filed for damages or injury arising out of or resulting from the performance of the Work, whether or not the Owner or Architect is named as a party, the Contractor shall immediately advise the Owner and Architect, in writing, of such claim or lawsuit and shall provide a full and complete copy of any documents or pleadings thereto, as well as a full and accurate report of the facts involved.

ARTICLE 4 ARCHITECT

§ 4.1 General

§ 4.1.1 The Architect is the person or entity retained by the Owner pursuant to Section 2.3.2 and identified as such in the Agreement. The Term "Architect," "Architect/Engineer," "Engineer," or "Design Professional" as used herein means the Architect or the Architect's authorized representative.

§ 4.1.2 Duties, responsibilities, and limitations of authority of the Architect as set forth in the Contract Documents shall not be restricted, modified, or extended without written consent of the ~~Owner, Contractor, and Architect. Consent shall not be unreasonably withheld.~~Owner and Architect.

§ 4.2 Administration of the Contract

§ 4.2.1 The Architect will provide administration of the Contract as described in the Contract Documents and will be an Owner's representative during construction until the date the Architect issues the final Certificate for ~~Payment.~~ Payment and with the Owner's written concurrence during the correction period. The Architect will have authority to act on behalf of the Owner only to the extent provided in the Contract Documents.

§ 4.2.2 The Architect will visit the site at intervals appropriate to the stage of construction, or ~~as otherwise agreed with the Owner, to become generally~~ more frequently as agreed with the Owner or required by law, to become familiar with the progress and quality of the portion of the Work completed, and to determine ~~in general~~ if the ~~Work observed is being performed in a manner indicating that the~~ Work, when fully completed, will be in accordance with the Contract Documents. ~~However, the Architect will not be required to make exhaustive or continuous on-site inspections to check the quality or quantity of the Work. The~~ Except as otherwise set forth herein or in the Owner/Architect Agreement, the Architect will not have control over, charge of, or responsibility for the construction means, methods, techniques, sequences or procedures, or for the safety precautions and programs in connection with the Work, since these are solely the Contractor's rights and responsibilities under the Contract Documents. The Architect shall provide all services and duties that may be performed by an "Architect" or "Engineer" in 1937 PA 306 and 1980 PA 299, including but not limited to supervision of construction.

§ 4.2.3 On the basis of the site visits, the Architect will keep the Owner ~~reasonably~~ informed about the progress and quality of the portion of the Work completed, will guard the Owner against defects and deficiencies in the Work, and promptly report to the Owner (1) known deviations from the Contract Documents, (2) known deviations from the most recent construction schedule submitted by the Contractor, and (3) defects and deficiencies observed in the Work. ~~The~~ Except as required by the Owner/Architect Agreement or other Contract Documents, the Architect will not be responsible for the Contractor's failure to perform the Work in accordance with the requirements of the Contract Documents. The Architect will not have control over or charge of, and, except as provided in the agreement between Owner and Architect or this document, will not be responsible for acts or omissions of, the Contractor, Subcontractors, or their agents or employees, or any other persons or entities performing portions of the Work. The Architect shall provide all services and duties that may be performed by an "Architect" or "Engineer" in 1937 PA 306 and 1980 PA 299, including but not limited to supervision of construction.

§ 4.2.4 Communications

The Owner and Contractor shall endeavor to include the Architect in all communications that relate to or affect the Architect's services or professional responsibilities. The Owner shall promptly notify the Architect of the substance of any direct communications between the Owner and the Contractor otherwise ~~relating to~~ materially affecting the Project. Communications by and with the Architect's consultants shall be through the Architect. Communications by and with Subcontractors and suppliers shall be through the Contractor. Communications by and with Separate Contractors shall be through the Owner. The Contract Documents may specify other communication protocols.

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§ 4.2.5 Based on the Architect's evaluations of the Contractor's Applications for Payment, the Architect will review and certify the amounts due the Contractor and will issue Certificates for Payment in such amounts.

§ 4.2.6 The Architect has authority to reject Work that does not conform to the Contract Documents. Whenever the Architect considers it necessary or advisable, the Architect will have authority to require inspection or testing of the Work in accordance with Sections 13.4.2 and 13.4.3, whether or not the Work is fabricated, installed or completed. However, neither this authority of the Architect nor a decision made in good faith either to exercise or not to exercise such authority shall give rise to a duty or responsibility of the Architect to the Contractor, Subcontractors, suppliers, their agents or employees, or other persons or entities performing portions of the Work.

§ 4.2.7 The Architect will review and approve, or take other appropriate action upon, the Contractor's submittals such as Shop Drawings, Product Data, and Samples, but only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Architect's action will be taken in accordance with the submittal schedule approved by the Owner and Architect or, in the absence of an approved submittal schedule, with reasonable promptness as to cause no delay in the Work while allowing sufficient time in the Architect's professional judgment to permit adequate review. Review of such submittals is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the Contractor as required by the Contract Documents. The Architect's review of the Contractor's submittals shall not relieve the Contractor of the obligations under Sections 3.3, 3.5, and 3.12. The Architect's review shall not constitute approval of safety precautions or of any construction means, methods, techniques, sequences, or procedures. The Architect's approval of a specific item shall not indicate approval of an assembly of which the item is a component. However, should the Architect discover during the course of such review any inaccuracies, incompleteness, or other irregularities, the Architect shall immediately notify the Owner of the same to determine an appropriate corrective course of action or notify the Contractor of the same to correct the irregularities.

§ 4.2.8 The Architect will ~~prepare~~ review and recommend for approval Change Orders and Construction Change Directives, and may order minor changes in the Work as provided in Section 7.4. The Architect will investigate and make determinations and recommendations regarding concealed and unknown conditions as provided in Section 3.7.4.

§ 4.2.9 The Architect will conduct inspections to ~~determine~~ determine, with the Owner's concurrence, the date or dates of Substantial Completion and the date of final completion; issue Certificates of Substantial Completion pursuant to Section 9.8; receive and forward to the Owner, for the Owner's review and records, written warranties and related documents required by the Contract and assembled by the Contractor pursuant to Section 9.10; and issue a final Certificate for Payment pursuant to Section 9.10.

§ 4.2.10 If the Owner and Architect agree, the Architect will provide one or more Project representatives to assist in carrying out the Architect's responsibilities at the site. ~~The Owner shall notify the Contractor of any change in the duties, responsibilities and limitations of authority of the Project representatives.~~

§ 4.2.11 The Architect will interpret ~~and decide~~ matters concerning performance under, and requirements of, the Contract Documents on written request of either the Owner or Contractor. The Architect's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable ~~promptness.~~ promptness given the particular circumstances.

§ 4.2.12 Interpretations ~~and decisions~~ of the Architect will be consistent with the intent of, and reasonably inferable from, the Contract Documents and will be in writing or in the form of drawings. When making such ~~interpretations and decisions,~~ interpretations, the Architect will endeavor to secure faithful performance by ~~both Owner and~~ Contractor, ~~will not show partiality to either,~~ and will not be liable for results of interpretations or decisions rendered in good ~~faith.~~ faith and without negligence.

§ 4.2.13 The Architect's ~~decisions~~ interpretations on matters relating to aesthetic effect will be final if consistent with the intent expressed in the Contract Documents.

§ 4.2.14 The Architect will review and respond to requests for information about the Contract Documents. The Architect's response to such requests will be made in writing within any time limits agreed upon or otherwise with

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reasonable ~~promptness.~~ promptness given the particular circumstances. If appropriate, the Architect will prepare and issue supplemental Drawings and Specifications in response to the requests for information.

ARTICLE 5 SUBCONTRACTORS

§ 5.1 Definitions

§ 5.1.1 A Subcontractor is a person or entity who has a direct contract with the Contractor to perform a portion of the Work at the site. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Subcontractor or an authorized representative of the Subcontractor. The term "Subcontractor" does not include a Separate Contractor or the subcontractors of a Separate Contractor. The term "Subcontractor" shall also include Sub-subcontractors at any tier and material and equipment suppliers. Each and every subcontract shall be understood to have the Owner as a third-party beneficiary, and the Owner shall enjoy all third-party beneficiary rights permitted by law.

§ 5.1.2 A Sub-subcontractor is a person or entity who has a direct or indirect contract with a Subcontractor to perform a portion of the Work at the site. The term "Sub-subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Sub-subcontractor or an authorized representative of the Sub-subcontractor.

§ 5.2 Award of Subcontracts and Other Contracts for Portions of the Work

§ 5.2.1 Unless otherwise stated in the Contract ~~Documents,~~ Documents or the bidding requirements, the Contractor, as soon as practicable after award of the Contract, shall notify the Owner and Architect in writing of the persons or entities proposed for each principal portion of the Work, including those who are to furnish materials or equipment fabricated to a special design. Within 14 days of receipt of the information, the Architect may notify the Contractor whether the Owner or the Architect (1) has reasonable objection to any such proposed person or entity or (2) requires additional time for review. ~~Failure of the Architect to provide notice within the 14-day period shall constitute notice of no reasonable objection.~~ All contractual agreements with additional persons or entities serving as a Subcontractor or supplier shall expressly identify the Owner as a third-party beneficiary, and the Owner shall enjoy all third-party beneficiary rights not prohibited by law.

§ 5.2.2 The Contractor shall not contract with a proposed person or entity to whom the Owner or Architect has made reasonable and timely objection. The Contractor shall not be required to contract with anyone to whom the Contractor has made reasonable objection.

§ 5.2.3 If the Owner or Architect has reasonable objection to a person or entity proposed by the Contractor, the Contractor shall propose another to whom the Owner or Architect has no reasonable objection. If the proposed but rejected Subcontractor was reasonably capable of performing the Work, despite the Architect's or Owner's reasonable objection, the Contract Sum and Contract Time shall be increased or decreased by the difference, if any, occasioned by such change, and an appropriate Change Order shall be issued before commencement of the substitute Subcontractor's Work. However, no increase in the Contract Sum or Contract Time shall be allowed for such change unless the Contractor has acted promptly and responsively in submitting names as required.

§ 5.2.4 The Contractor shall not substitute a Subcontractor, person, or entity for one previously selected if the Owner or Architect makes reasonable objection to such substitution. The Contractor shall notify the Owner and Architect of any proposed substitution a minimum of ten (10) days prior to such proposed change.

§ 5.3 Subcontractual Relations

By appropriate written agreement, the Contractor shall require each Subcontractor, to the extent of the Work to be performed by the Subcontractor, to be bound to the Contractor by terms of the Contract Documents, and to assume toward the Contractor all the obligations and responsibilities, including the responsibility for safety of the Subcontractor's Work that the Contractor, by these Contract Documents, assumes toward the Owner and Architect. Each subcontract agreement shall preserve and protect the rights of the Owner and Architect under the Contract Documents with respect to the Work to be performed by the Subcontractor so that subcontracting thereof will not prejudice such rights, and shall allow to the Subcontractor, unless specifically provided otherwise in the subcontract agreement, the benefit of all rights, remedies, and redress against the Contractor that the Contractor, by the Contract Documents, has against the Owner. Where appropriate, the Contractor shall require each Subcontractor to enter into similar agreements with Sub-subcontractors. The Contractor shall make available to each proposed Subcontractor, prior to the execution of the subcontract agreement, copies of the Contract Documents to which the Subcontractor will be bound, and, upon written request of the Subcontractor, identify to the Subcontractor terms and conditions of the

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proposed subcontract agreement that may be at variance with the Contract Documents. Subcontractors will similarly make copies of applicable portions of such documents available to their respective proposed Sub-subcontractors.

§ 5.4 Contingent Assignment of Subcontracts

§ 5.4.1 Each subcontract agreement for a portion of the Work that is assigned by the Contractor to the Owner, provided that

.1 assignment is effective only after termination of the Contract by the Owner for cause pursuant to Section 14.2 and only for those subcontract agreements that the Owner accepts by notifying the Subcontractor and ~~Contractor;~~ Contractor in writing; and

.2 assignment is subject to the prior rights of the surety, if any, obligated under bond relating to the Contract.

When the Owner accepts the assignment of a subcontract agreement, the Owner assumes the Contractor's rights and obligations under the subcontract.

§ 5.4.2 Upon such assignment, if the Work has been suspended for more than 30 days, the Subcontractor's compensation ~~shall be equitably adjusted for increases in cost resulting from the suspension.~~may be adjusted as negotiated by the parties.

§ 5.4.3 Upon assignment to the Owner under this Section 5.4, the Owner may further assign the subcontract to a successor contractor or other entity. ~~If the Owner assigns the subcontract to a successor contractor or other entity, the Owner shall nevertheless remain legally responsible for all of the successor contractor's obligations under the subcontract.~~

ARTICLE 6 CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS

§ 6.1 Owner's Right to Perform Construction and to Award Separate Contracts

§ 6.1.1 The term "Separate Contractor(s)" shall mean other contractors retained by the Owner under separate agreements. The Owner reserves the right to perform construction or operations related to the Project with the Owner's own forces, and with Separate Contractors retained under Conditions of the Contract substantially similar to those of this Contract, including those provisions of the Conditions of the Contract related to insurance and waiver of subrogation. The Contractor shall be responsible for coordinating the Work with the work of other Contractors, including the Owner's own forces or Separate Contractors, so as to complete the Work in accordance with the Project time schedule.

§ 6.1.2 When separate contracts are awarded for different portions of the Project or other construction or operations on the site, the term "Contractor" in the Contract Documents in each case shall mean the Contractor who executes each separate Owner-Contractor Agreement.

§ 6.1.3 The Owner shall provide for coordination of the activities of the Owner's own forces and of each Separate Contractor with the Work of the Contractor, who shall cooperate with them. The Contractor shall participate with any Separate Contractors and the Owner in reviewing their construction schedules. The Contractor shall make any revisions to its construction schedule deemed necessary after a joint review and mutual agreement. The construction schedules shall then constitute the schedules to be used by the Contractor, Separate Contractors, and the Owner until subsequently revised.

§ 6.1.4 ~~Unless otherwise provided in the Contract Documents, when the Owner performs construction or operations related to the Project with the Owner's own forces or with Separate Contractors, the Owner or its Separate Contractors shall have the same obligations and rights that the Contractor has under the Conditions of the Contract, including, without excluding others, those stated in Article 3, this Article 6, and Articles 10, 11, and 12.~~**NOT USED.**

§ 6.2 Mutual Responsibility

§ 6.2.1 The Contractor shall afford the Owner and Separate Contractors reasonable opportunity for introduction and storage of their materials and equipment and performance of their activities, and shall connect and coordinate the Contractor's construction and operations with theirs as required by the Contract Documents.

§ 6.2.2 If part of the Contractor's Work depends for proper execution or results upon construction or operations by the Owner or a Separate Contractor, the Contractor shall, prior to proceeding with that portion of the Work, promptly

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notify the Architect of apparent discrepancies or defects in the construction or operations by the Owner or Separate Contractor that would render it unsuitable for proper execution and results of the Contractor's Work. Failure of the Contractor to notify the Architect of apparent discrepancies or defects prior to proceeding with the Work shall constitute an acknowledgment that the Owner's or Separate Contractor's completed or partially completed construction is fit and proper to receive the Contractor's Work. The Contractor shall not be responsible for discrepancies or defects in the construction or operations by the Owner or Separate Contractor that are not ~~apparent.~~ reasonably discoverable.

§ 6.2.3 The Contractor shall reimburse the Owner for costs the Owner incurs that are payable to a Separate Contractor because of the Contractor's delays, improperly timed activities or defective construction. The Owner shall be responsible to the Contractor for costs the Contractor incurs because of a Separate Contractor's ~~delays, improperly timed activities,~~ damage to the Work or defective construction.

§ 6.2.4 The Contractor shall promptly remedy damage that the Contractor ~~wrongfully~~ causes to completed or partially completed construction or to property of the Owner or Separate Contractor as provided in Section 10.2.5.

§ 6.2.5 The Owner and each Separate Contractor shall have the same responsibilities for cutting and patching as are described for the Contractor in Section 3.14.

§ 6.3 Owner's Right to Clean Up

If a dispute arises among the Contractor, Separate Contractors, and the Owner as to the responsibility under their respective contracts for maintaining the premises and surrounding area free from waste materials and rubbish, the Owner may clean up and ~~the Architect will~~ allocate the cost among those responsible. The Owner's right to clean up shall in no event be deemed a duty, and should the Owner choose not to pursue this remedy, the Contractor necessitating such action shall remain fully responsible for the same.

ARTICLE 7 CHANGES IN THE WORK

§ 7.1 General

§ 7.1.1 Changes in the Work may be accomplished after execution of the Contract, and without invalidating the Contract, only by Change Order, Construction Change ~~Directive~~ Directive, written contract amendment, or order for a minor change in the Work, subject to the limitations stated in this Article 7 and elsewhere in the Contract Documents.

§ 7.1.2 A Change Order shall be based upon agreement among the Owner, Contractor, and Architect. A Construction Change Directive ~~requires agreement~~ may be issued by the Owner and Architect and may or may not be agreed to by the Contractor. An order for a minor change in the Work may be issued by the Architect alone.

§ 7.1.3 Changes in the Work shall be performed under applicable provisions of the Contract Documents. The Contractor shall proceed promptly with changes in the Work, unless otherwise provided in the Change Order, Construction Change Directive, or order for a minor change in the Work.

§ 7.2 Change Orders

§ 7.2.1 A Change Order is a written instrument prepared by the Architect and signed by the Owner, Contractor, and Architect stating their agreement upon all of the following:

- **.1** The change in the Work;
- **.2** The amount of the adjustment, if any, in the Contract Sum; and
- **.3** The extent of the adjustment, if any, in the Contract Time.

§ 7.2.2 Unless expressly stated otherwise in the Change Order, an agreement on any Change Order shall constitute the Contractor's final position on all matters relating to the change in the work that is subject to the Change Order, including, but not limited to, all direct and indirect costs associated with such change and any and all adjustments to the Contract Sum and the Contract Time.

§ 7.3 Construction Change Directives

§ 7.3.1 A Construction Change Directive is a written order prepared by the Architect and signed by the Owner and Architect, directing a change in the Work prior to agreement on adjustment, if any, in the Contract Sum or Contract Time, or both. The Owner may by Construction Change Directive, without invalidating the Contract, order changes in

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the Work within the general scope of the Contract consisting of additions, deletions, or other revisions, the Contract Sum and Contract Time being adjusted accordingly.

§ 7.3.2 A Construction Change Directive shall be used in the absence of total agreement on the terms of a Change Order.

§ 7.3.3 If the Construction Change Directive provides for an adjustment to the Contract Sum, the adjustment shall be based on one or more of the following methods:

.1 Mutual acceptance of a lump sum properly itemized and supported by sufficient substantiating data to permit evaluation;

.2 Unit prices stated in the Contract Documents or subsequently agreed upon;

.3 Cost to be determined in a manner agreed upon by the parties and a mutually acceptable fixed or percentage fee; or

.4 As provided in Section 7.3.4.

However, the Contract Time shall be adjusted only if the Contractor demonstrates to the Owner that the changes in the Work required by the Construction Change Directive adversely affect the critical path of the Work.

§ 7.3.4 If the Contractor does not respond promptly or disagrees with the method for adjustment in the Contract Sum, the Architect shall ~~determine~~ determine, with the Owner's approval, the adjustment on the basis of reasonable expenditures and savings of those performing the Work attributable to the change, including, in case of an increase in the Contract Sum, an amount for overhead and profit as set forth in the Agreement, or if no such amount is set forth in the Agreement, a reasonable amount. In such case, and also under Section 7.3.3.3, the Contractor shall keep and present, in such form as the Architect may prescribe, an itemized accounting together with appropriate supporting data. Unless otherwise provided in the Contract Documents, costs for the purposes of this Section 7.3.4 shall be limited to ~~the following:~~ a reasonable amount of the following that are actually incurred by the Contractor:

.1 Costs of labor, including applicable payroll taxes, fringe benefits required by agreement or custom, workers' compensation insurance, and other employee costs approved by the Architect;

.2 Costs of materials, supplies, and equipment, including cost of transportation, whether incorporated or consumed;

.3 Rental costs of machinery and equipment, exclusive of hand tools, whether rented from the Contractor or others;

.4 Costs of premiums for all bonds and insurance, permit fees, and sales, use, or similar taxes, directly related to the change; and

.5 Costs of supervision and field office personnel directly attributable to the change.

§ 7.3.5 If the Contractor disagrees with the adjustment in the Contract Time, the Contractor may make a Claim in accordance with applicable provisions of Article 15.

§ 7.3.6 Upon receipt of a Construction Change Directive, the Contractor shall promptly proceed with the change in the Work involved and advise the Architect of the Contractor's agreement or disagreement with the method, if any, provided in the Construction Change Directive for determining the proposed adjustment in the Contract Sum or Contract Time. Contractor agreements to a Construction Change Directive shall require a follow-up writing or signature as contemplated in Section 7.3.7.

§ 7.3.7 A Construction Change Directive signed by the Contractor indicates the Contractor's agreement therewith, including adjustment in Contract Sum and Contract Time or the method for determining them. Such agreement shall be effective immediately and shall be recorded as a Change Order.

§ 7.3.8 The amount of credit to be allowed by the Contractor to the Owner for a deletion or change that results in a net decrease in the Contract Sum shall be actual net cost as confirmed by the Architect. When both additions and credits covering related Work or substitutions are involved in a change, the allowance for overhead and profit shall be figured on the basis of net increase, if any, with respect to that change.

§ 7.3.9 Pending final determination of the total cost of a Construction Change Directive to the Owner, the Contractor may request payment for undisputed Work completed under the Construction Change Directive in Applications for Payment. ~~The~~ For those undisputed portions, the Architect will make an interim determination for purposes of

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monthly certification for payment for those costs and certify for payment the amount that the Architect determines, in the Architect's professional judgment, to be reasonably justified. The Architect's interim determination of ~~cost~~ cost, if agreed to by the Owner in writing, shall adjust the Contract Sum on the same basis as a Change Order, subject to the right of ~~either party~~ the Contractor to disagree and assert a Claim in accordance with Article 15.

§ 7.3.10 When the Owner and Contractor agree in writing with a determination made by the Architect concerning the adjustments in the Contract Sum and Contract Time, or otherwise reach agreement upon the ~~adjustments,~~ adjustments in writing, such agreement shall be effective immediately and the Architect will prepare a Change Order. Change Orders may be issued for all or any part of a Construction Change Directive.

§ 7.3.11 In no event shall the Contractor be entitled to receive, and the contractor hereby waives the right to receive, any payment or any extension of time for additional or changed work, whether partially or fully completed or simply proposed, unless such additional work is authorized by a written Change Order or Construction Change Directive signed by the Owner, nor shall the Contractor be obligated to proceed with any such work. Only the Owner shall have the right to issue a written Change Order or Constructive Change Directive to the Contractor authorizing an addition, deletion or other revision in the scope of the Work and/or an adjustment in the Contract Sum or the Construction Schedule.

§ 7.4 Minor Changes in the Work

The Architect may order minor changes in the Work that are consistent with the intent of the Contract Documents and do not involve an adjustment in the Contract Sum or an extension of the Contract Time. The Architect's order for minor changes shall be in writing. If the Contractor believes that the proposed minor change in the Work will affect the Contract Sum or Contract Time, the Contractor shall either (i) file a Claim in accordance with Article 15 and continue to implement the change in the Work, or (ii) notify the Owner and Architect in writing and shall not proceed to implement the change in the Work. ~~If~~ Without limiting other restrictions on payment, if the Contractor performs the Work set forth in the Architect's order for a minor change without prior notice to the Architect that such change will affect the Contract Sum or Contract Time, the Contractor waives any adjustment to the Contract Sum or extension of the Contract Time.

ARTICLE 8 TIME

§ 8.1 Definitions

§ 8.1.1 Unless otherwise provided, Contract Time is the period of time, including authorized adjustments, allotted in the Contract Documents for Substantial Completion of the Work.

§ 8.1.2 The date of commencement of the Work is the date established in the Agreement.

§ 8.1.3 The date of Substantial Completion is the date certified by the Architect in accordance with Section 9.8.

§ 8.1.4 The term "day" as used in the Contract Documents shall mean calendar day unless otherwise specifically defined.

§ 8.2 Progress and Completion

§ 8.2.1 Time limits stated in the Contract Documents are of the essence of the Contract. By executing the Agreement, the Contractor confirms that the Contract Time is a reasonable period for obtaining all supplies, materials, tools and equipment necessary to perform the Work and for properly performing the Work.

§ 8.2.2 The Contractor shall not knowingly, except by agreement or instruction of the Owner in writing, commence the Work prior to the effective date of insurance required to be furnished by the Contractor and Owner.

§ 8.2.3 The Contractor shall proceed expeditiously with adequate forces and shall achieve Substantial Completion within the Contract Time. All work shall be completed in sufficient time to allow for clean-up and preparation for Owner move-in prior to the Date of Substantial Completion.

§ 8.3 Delays and Extensions of Time

§ 8.3.1 ~~If~~ Provided the Contractor submits a written request for an extension not more than fourteen (14) days after the occurrence that gives rise to the delay, if the Contractor is delayed at any time in the commencement or progress of the Work by (1) an act or neglect of the Owner or Architect, of an employee of either, or of a Separate Contractor; (2) by changes ordered in the Work; (3) by ~~labor disputes, fire, unusual delay in deliveries,~~ fire, government-declared

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emergencies, unavoidable casualties, adverse weather conditions documented in accordance with Section 15.1.6.2, or other causes beyond the Contractor's control; (4) by delay authorized by the Owner pending ~~mediation and binding dispute resolution;~~ litigation, mediation, arbitration or binding dispute resolution, as applicable; or (5) by other causes that the Contractor asserts, and the Architect determines, justify delay, then the Contract Time shall be extended for such reasonable time as the Architect may ~~determine.~~
determine and with which the Owner agrees. Failure of the Contractor to submit a timely request for an extension shall irrevocably waive the Contractor's right to such an extension of time. If the Contract Time is subject to extension pursuant to this subparagraph, the Contractor shall receive such an extension, and subject to Owner review and written approval, may receive extension costs related to Construction Management staff and GC costs.

§ 8.3.2 Claims relating to time shall be made in accordance with applicable provisions of Article 15.

§ 8.3.3 This Section 8.3 does not preclude recovery of damages for delay by either party under other provisions of the Contract Documents. Only upon Owner review and written approval, the Contractor may receive extension costs related to Construction Management staff and GC costs..

§ 8.4 Delay Damage Claims

§ 8.4.1 In the absence of a delay caused by something outside the Contractor's reasonable control, if the Contractor fails to complete its Work on time resulting in loss or damage to the Owner, whether or not liquidated damages are called for in the Contract Documents, the Owner shall be entitled to make a Claim for direct damages caused by the Contractor's delay.

§ 8.4.2 In the event the Contractor is hindered in the commencement or progress of the Work for any reason by someone other than the Owner, and in the event the Contractor claims damages as a direct and proximate consequence thereof (including, but not limited to, extended general conditions, overhead, profit, overtime, interest, supervision or other costs or profits whatsoever), then the Contractor shall only assert claims against the Owner related to extended general conditions and costs of paying staff.

For any delay claims raised against the Owner for any reason, the Contractor's sole and exclusive remedy is an extension of time to perform the Work not to exceed the time frame of any proven delay. Under no circumstances is the Contractor entitled to monetary delay damages from the Owner.

§ 8.4.3 Notwithstanding the foregoing, in the event of any delay in the completion of the Contractor's Work or scheduling of the Contractor's Work, including the sequence of that Work which is attributable to the Owner, and if it is determined by a court of competent jurisdiction that the Owner is liable for such delay despite the other terms of this Contract barring any Owner liability for damages for delay, then the Owner shall be liable to the Contractor for liquidated damages in the amount of not to exceed One Hundred Dollars ($100) per day, maximum, which shall include all of the Contractor's claims, including by way of example, delays, compressions of schedule, lost productivity, lost profits, lost opportunities, out of sequence work, overhead, crowding, tools, equipment, rentals, etc.

ARTICLE 9 PAYMENTS AND COMPLETION

§ 9.1 Contract Sum

§ 9.1.1 The Contract Sum is stated in the Agreement and, including authorized adjustments, is the total amount payable by the Owner to the Contractor for performance of the Work under the Contract Documents.

§ 9.1.2 If unit prices are stated in the Contract Documents or subsequently agreed upon, and if quantities originally contemplated are materially changed so that application of such unit prices to the actual quantities causes substantial inequity to the Owner or Contractor, the applicable unit prices shall be equitably adjusted.

§ 9.2 Schedule of Values

~~Where the Contract is based on a stipulated sum or Guaranteed Maximum Price, the~~ The Contractor shall submit a schedule of values to the Architect before the first Application for Payment, allocating the entire Contract Sum to the various portions of the Work. The schedule of values shall be prepared in the form, and supported by the data to substantiate its accuracy, required by the Architect. This schedule, unless objected to by the Architect, shall be used as a basis for reviewing the Contractor's Applications for Payment. Any changes to the schedule of values shall be submitted to the Architect and supported by such data to substantiate its accuracy as the Owner or Architect may require, and unless objected to by the Owner or Architect, shall be used as a basis for reviewing the Contractor's subsequent Applications for Payment.

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§ 9.2.1 The schedule of values shall be prepared in such manner that the value associated for each major item of work and each subcontracted item of work is shown with materials and labor indicated separately on AIA Document G702 - Application and Certificate of Payment, and AIA Document G703 - Continuation Sheet, or otherwise.

§ 9.3 Applications for Payment

§ 9.3.1 At least ~~ten~~ fifteen (15) days before the date established for each progress payment, the Contractor shall submit to the Architect an itemized Application for Payment prepared in accordance with the schedule of ~~values, if required under Section 9.2,~~ values for completed portions of the Work. The application shall be notarized, if required, and supported by all data substantiating the Contractor's right to payment that the Owner or Architect require, such as copies of requisitions, and releases and waivers of liens from Subcontractors and suppliers, and shall reflect retainage if provided for in the Contract Documents. The form of Application and Certificate for Payment shall be AIA Document G702, Application and Certification for Payment, supported by AIA Document G703, Continuation Sheet, unless otherwise agreed by the Owner. Applications for Payment are due to the office of the Architect by the designated day of the month. Applications for Payment that are received after the specified date will not be processed until the following month.

§ 9.3.1.1 As provided in Section 7.3.9, such applications may include requests for payment on account of changes in the Work that have been properly authorized by Construction Change Directives, or by interim determinations of the Architect, but not yet included in Change Orders. A request for payment of sums related to work regarding Construction Change Directives shall, unless qualified in writing at the time of request, constitute full and complete consent to the Construction Change Directive(s) and to the issuance of a Change Order.

§ 9.3.1.2 Applications for Payment shall not include requests for payment for portions of the Work for which the Contractor does not intend to pay a Subcontractor or supplier, unless such Work has been performed by others whom the Contractor intends to pay.

§ 9.3.1.3 The Contractor shall submit with each monthly Application for Payment (1) an Affidavit that payrolls, bills for materials and equipment, and other indebtedness connected with the Work for which the previous application was submitted and for which the Owner might in any way be responsible have been paid or otherwise satisfied, and (2) a release or waiver of liens arising out of the Contract from each Contractor and/or Subcontractor, materialman, supplier and laborer for the Contractor addressing all previous Applications for Payment submitted for the Project.

§ 9.3.1.4 The Contractor must provide copies of the insurance certificates, bonds, and the same for all of the Subcontractors prior to submitting the first Application for Payment.

§ 9.3.2 Unless otherwise provided in the Contract Documents, payments shall be made on account of materials and equipment delivered and suitably stored at the site for subsequent incorporation in the Work. If approved in advance by the Owner, payment may similarly be made for materials and equipment suitably stored off the site at a location agreed upon in writing. Payment for materials and equipment stored on or off the site shall be conditioned upon compliance by the Contractor with procedures satisfactory to the Owner to establish the Owner's title to such materials and equipment or otherwise protect the Owner's interest, and shall include the costs of applicable insurance, storage, and transportation to the site, for such materials and equipment stored off the site. Payment to Contractor for materials stored off site is discouraged. When circumstances indicate that the Owner's best interest is served by off-site storage, the Contractor shall make written request to the Owner for approval to include such material costs in the next progress payment. The Contractor's request shall include the following information:

.1 A list of the fabricated materials consigned to the Project (which shall be clearly identified, giving the place of storage, together with copies of invoices and reasons why materials cannot be delivered to the site.

.2 Certification that items have been tagged for delivery to the Project and that they will not be used for another purpose.

.3 A letter from the Contractor's Surety indicating agreement to the arrangements and that payment to the Contractor shall not relieve either party of their responsibility to complete the Work.

.4 Evidence of adequate insurance covering the material in storage, which shall name the Owner as additionally insured.

.5 Costs incurred by the Architect to inspect material in off-site storage shall be paid by the Contractor.

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.6 Subsequent pay requests shall itemize the materials and their cost which were approved on previous pay requests and remain in off-site storage.

.7 When a partial payment is allowed on account of material delivered on the site of the Work or in the vicinity thereof or under possession and control of the Contractor, but not yet incorporated therein, such material shall become the property of the Owner, but if such material is stolen, destroyed or damaged by casualty before being used, the Contractor will be required to replace it at its own expense.

§ 9.3.3 The Contractor warrants that title to all Work covered by an Application for Payment will pass to the Owner no later than the time of payment. The Contractor further warrants that upon submittal of an Application for Payment all Work for which Certificates for Payment have been previously issued and payments received from the Owner shall, to the best of the Contractor's knowledge, information, and belief, be free and clear of liens, claims, security interests, or encumbrances, in favor of the Contractor, Subcontractors, suppliers, or other persons or entities that provided labor, materials, and equipment relating to the Work.

§ 9.4 Certificates for Payment

§ 9.4.1 The Architect will, within seven days after receipt of the Contractor's Application for Payment, either (1) issue to the Owner a Certificate for Payment in the full amount of the Application for Payment, with a copy to the Contractor; or (2) issue to the Owner a Certificate for Payment for such amount as the Architect determines is properly due, and notify the Contractor and Owner of the Architect's reasons for withholding certification in part as provided in Section 9.5.1; or (3) withhold certification of the entire Application for Payment, and notify the Contractor and Owner of the Architect's reason for withholding certification in whole as provided in Section 9.5.1.

§ 9.4.2 The issuance of a Certificate for Payment will constitute a representation by the Architect to the Owner, based on the Architect's evaluation of the Work and the data in the Application for Payment, that, to the best of the Architect's knowledge, information, and belief, the Work has progressed to the point indicated, the quality of the Work is in aeeordance with the Contract Documents, and that the Contractor is entitled to payment in the amount certified. The foregoing representations are subject to an evaluation of the Work for eonformance with the Contract Documents upon Substantial Completion, to results of subsequent tests and inspections, to correction of minor deviations from the Contract Documents prior to completion, and to specific qualifications expressed by the ~~Architect. However,~~ Architect, in writing, together with the certification to which it pertains. However, unless otherwise required by the Owner/Architect Agreement, any other Contract Document, or applicable law, the issuance of a Certificate for Payment will not be a representation that the Architect has (1) made exhaustive or continuous on-site inspections to check the quality or quantity of the Work; (2) reviewed construction means, methods, techniques, sequences, or procedures; (3) reviewed copies of requisitions received from Subcontractors and suppliers and other data requested by the Owner to substantiate the Contractor's right to payment; or (4) made examination to ascertain how or for what purpose the Contractor has used money previously paid on account of the Contract Sum. Nothing in this Section 9.4.2 shall be interpreted to reduce or eliminate the Architect's duties as set forth in Section 3.1.9 of the Owner/Architect Agreement, including supervision of construction.

§ 9.5 Decisions to Withhold Certification

§ 9.5.1 The Architect may withhold a Certificate for Payment in whole or in part, to the extent reasonably necessary to protect the Owner, if in the Architect's opinion the representations to the Owner required by Section 9.4.2 cannot be made. If the Architect is unable to certify payment in the amount of the Application, the Architect will notify the Contractor and Owner as provided in Section 9.4.1. If the Contractor and Architect cannot agree on a revised amount, the Architect will promptly issue a Certificate for Payment for the amount for which the Architect is able to make such representations to the Owner. The Architect may also withhold a Certificate for Payment or, because of subsequently discovered evidence, may nullify the whole or a part of a Certificate for Payment previously issued, to such extent as may be necessary in the Architect's opinion to protect the Owner from loss for which the Contractor is responsible, including loss resulting from acts and omissions described in Section 3.3.2, because of

.1 defective Work not ~~remedied;~~remedied, or the Contractor is in default on the Agreement;

.2 third party claims filed or reasonable evidence indicating probable filing of such claims, unless security acceptable to the Owner is provided by the Contractor;

.3 failure of the Contractor to make payments properly to Subcontractors or suppliers for labor, materials or equipment;

.4 reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Sum;

.5 damage to the Owner or a Separate Contractor;

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.6 reasonable evidence that the Work will not be completed within the Contract Time, and that the unpaid balance would not be adequate to cover actual or liquidated damages for the anticipated delay;~~or~~

.7 ~~repeated~~ failure to carry out the Work in accordance with the Contract ~~Documents.~~ Documents;

.8 the Work not having progressed to the extent set forth in the Application for Payment;

.9 representations of the Contractor are untrue;

.10 failing to conform to Project Schedule;

.11 default in the performance of any obligation to the Owner under another contract; or

.12 failure to provide sufficiently skilled workers.

§ 9.5.2 When ~~either party~~ the Contractor disputes the Architect's decision regarding a Certificate for Payment under Section 9.5.1, in whole or in part, ~~that party~~ the Contractor may submit a Claim in accordance with Article 15.

§ 9.5.3 When the reasons for withholding certification are removed, certification will be made for amounts previously withheld.

§ 9.5.4 If the Architect withholds certification for payment under Section 9.5.1.3, the Owner may, at its sole option, issue joint checks to the Contractor and to any Subcontractor or supplier to whom the Contractor failed to make payment for Work properly performed or material or equipment suitably delivered. If the Owner makes payments by joint check, the Owner shall notify the Architect and the Contractor shall reflect such payment on its next Application for Payment.

§ 9.5.5 If the Contractor disputes any determination by the Owner or Architect with regard to any Certificate for Payment, the Contractor shall nevertheless continue to expeditiously perform the Work and such dispute shall provide no basis for any manner of suspension of the Contractor's performance of the Work.

§ 9.5.6 Notwithstanding anything herein to the contrary, the Owner has no obligation to pay the Contractor absent receipt of a Certificate for Payment for the requested amount, and neither the Architect's failure to issue a Certificate for Payment nor the Architect's failure to notify the Contractor and/or Owner of a withheld Certificate for Payment creates an obligation on the Owner to pay the Contractor. The foregoing sentence shall not operate to limit the right of the Owner to dispute amounts requested by the Contractor or to withhold payments from the Contractor as provided in the Contract Documents.

§ 9.6 Progress Payments

§ 9.6.1 After the Architect has issued a Certificate for Payment, the Owner shall make payment in the manner and within the time provided in the Contract Documents, and shall so notify the Architect.

§ 9.6.2 The Contractor shall pay each Subcontractor, no later than seven days after receipt of payment from the Owner, the amount to which the Subcontractor is entitled, reflecting percentages actually retained from payments to the Contractor on account of the Subcontractor's portion of the Work. The Contractor shall, by appropriate agreement with each Subcontractor, require each Subcontractor to make payments to Sub-subcontractors in a similar manner.

§ 9.6.3 The Architect will, on request, furnish to a Subcontractor, if practicable, information regarding percentages of completion or amounts applied for by the Contractor and action taken thereon by the Architect and Owner on account of portions of the Work done by such Subcontractor.

§ 9.6.4 The Owner has the right to request written evidence from the Contractor that the Contractor has properly paid Subcontractors and suppliers amounts paid by the Owner to the Contractor for subcontracted Work. If the Contractor fails to furnish such evidence within seven days, the Owner shall have the right to contact Subcontractors and suppliers to ascertain whether they have been properly paid. Neither the Owner nor Architect shall have an obligation to pay, or to see to the payment of money to, a Subcontractor or supplier, except as may otherwise be required by law.

§ 9.6.5 The ~~Contractor's payments to suppliers shall be treated in a manner similar to that provided in Sections 9.6.2, 9.6.3 and 9.6.4.~~Owner may, in its sole discretion, after providing Contractor with ten (10) days prior written notice, make direct payments to the Contractor's Subcontractors, suppliers, laborers or claimants relating to labor or material provided to the Contractor for which the Contractor has not provided a waiver of lien, in the event the Subcontractors, suppliers, laborers or claimants threaten to or actually cease providing labor and/or materials for the Project such that, in the Owner's determination, progress of the Project and the Project's Schedule are jeopardized. All payments made

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pursuant to this section shall be considered the same as if paid directly to the Contractor and shall constitute partial payment of the Contract Sum. In the event the Contractor disagrees with the amount proposed to be paid to one or more Subcontractors, suppliers, laborers or claimants, the Contractor shall provide a bond in the amount the Contractor believes the Owner will overpay, within ten (10) days of receipt of notice, or be barred from making any claim that the amount of the direct payment was incorrect. Payment under this provision shall not jeopardize any other remedy available to the Owner.

§ 9.6.6 A Certificate for Payment, a progress payment, or partial or entire use or occupancy of the Project by the Owner shall not constitute acceptance of Work not in accordance with the Contract Documents.

§ 9.6.7 Unless the Contractor provides the Owner with a payment bond in the full penal sum of the Contract Sum, payments received by the Contractor for Work properly performed by Subcontractors or provided by suppliers shall be held by the Contractor for those Subcontractors or suppliers who performed Work or furnished materials, or both, under contract with the Contractor for which payment was made by the Owner. Nothing contained herein shall require money to be placed in a separate account and not commingled with money of the Contractor, create any fiduciary liability or tort liability on the part of the Contractor for breach of trust, or entitle any person or entity to an award of punitive damages against the Contractor for breach of the requirements of this provision.

§ 9.6.8 Provided the Owner has fulfilled its payment obligations under the Contract Documents, the Contractor shall defend and indemnify the Owner from all loss, liability, damage or expense, including reasonable attorney's fees and litigation expenses, arising out of any lien claim or other claim for payment by any Subcontractor or supplier of any tier. Upon receipt of notice of a lien claim or other claim for payment, the Owner shall notify the Contractor. If approved by the applicable court, when required, the Contractor may substitute a surety bond for the property against which the lien or other claim for payment has been asserted.

§ 9.6.9 Subject to applicable law, if a petition in bankruptcy or any other arrangement or proceeding regarding insolvency, assignment for the benefit of creditors, trust, chattel mortgage, or similar state or federal proceeding, whether voluntary or involuntary, shall be filed with respect to the Contractor, the Owner may withhold the final balance, or any other payments, whether or not an application for progress payment has been properly filed, until expiration of the period of any guarantees or warranties required for the Contractor, and the Owner may pay out such funds the amount necessary to satisfy any claims or costs that otherwise would have been covered by such guarantees or warranties.

§ 9.7 Failure of Payment

If ~~the Architect does not issue a Certificate for Payment, through no fault of the Contractor, within seven days after receipt of the Contractor's Application for Payment, or if~~ without justifiable basis under the Contract Documents, including these General Conditions, the Owner does not pay the Contractor within seven days after the date established in the Contract ~~Documents, the amount certified by the Architect or awarded by binding dispute resolution, then the Contractor may, upon seven additional days'~~ Documents the undisputed amount asserted by the Contractor in its Application for Payment or awarded by a court, then the Contractor may, upon twenty-one (21) additional days' written notice to the Owner and Architect, stop the Work until payment of the undisputed amount owing has been received. The Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable costs of shutdown, delay and start-up, plus interest as provided for in the Contract Documents. The Contractor acknowledges the Owner's right to dispute in good faith any amount requested by the Contractor, and, irrespective of the Architect's issuance of a Certificate for Payment, the Owner's right to withhold payments from the Contractor, including, without limitation, to correct Work that fails to conform with the Contract Documents or as an offset or recoupment to recover the cost of damages incurred by the Owner due to the Contractor's breach of the Contract or a wrongful or negligent act or omission of the Contractor.

§ 9.8 Substantial Completion

§ 9.8.1 Substantial Completion is the stage in the progress of the Work when the Work or designated portion thereof is sufficiently complete in accordance with the Contract Documents and when all required occupancy permits, if any, have been issued, so that the Owner can occupy or utilize the Work for its intended use.

§ 9.8.2 When the Contractor considers that the Work, or a portion thereof which the Owner agrees to accept separately, is substantially complete, the Contractor shall prepare and submit to the Architect a comprehensive list of

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items to be completed or corrected prior to final payment. Failure to include an item on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

§ 9.8.3 Upon receipt of the Contractor's list, the Architect will make an inspection to determine whether the Work or designated portion thereof is substantially complete. If the Architect's inspection discloses any item, whether or not included on the Contractor's list, which is not sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work or designated portion thereof for its intended use, the Contractor shall, before issuance of the Certificate of Substantial Completion, complete or correct such item ~~upon notification by the Architect.~~ immediately. In such case, the Contractor shall then submit a request for another inspection by the Architect to determine Substantial Completion.

§ 9.8.4 When the Work or designated portion thereof is substantially complete, the Architect will prepare a Certificate of Substantial Completion that shall establish the date of Substantial Completion; establish responsibilities of the Owner and Contractor for security, maintenance, heat, utilities, damage to the Work and insurance; and fix the time within which the Contractor shall finish all items on the list accompanying the Certificate. Warranties required by the Contract Documents shall commence on the date of Substantial Completion of the Work or designated portion thereof unless otherwise provided in the Certificate of Substantial Completion.

§ 9.8.5 The Certificate of Substantial Completion shall be submitted to the Owner and Contractor for their written acceptance of responsibilities assigned to them in the Certificate. Upon such acceptance, and consent of surety if any, the Owner shall make payment of retainage applying to the Work or designated portion thereof. Such payment shall be adjusted for Work that is incomplete or not in accordance with the requirements of the Contract Documents.

§ 9.8.6 Notwithstanding Sections 9.8.1 and 9.8.2, as a condition precedent to establishing the date of Substantial Completion, the Contractor shall prepare and submit to the Architect a comprehensive list of items to be completed or corrected (a "punch list"). The Contractor shall respond immediately to correct Work deficiencies and/or punch list items. Should the Contractor fail to make corrections in a timely fashion, but not later than fifteen (15) calendar days from the date of Substantial Completion or notification of the required corrections, whichever is earlier, such Work may be corrected by the Owner at the Contractor's sole expense, and any remaining payments due the Contractor shall be withheld by the Owner.

§ 9.8.7 The Contractor shall promptly notify the Architect, in writing, when the Work deficiencies and/or punch list items are completed. Upon the review of the Work by the Architect after such notification by the Contractor, if Work deficiencies and/or punch list items shall continue to exist, the Contractor shall reimburse the Owner its cost plus ten percent (10%) overhead and profit on any cost incurred by the Owner, including the Architect's fees for re- inspection of the Work. Failure to pay such costs within ten (10) days of receipt of a demand regarding the same shall permit the Owner to pay such costs out of retainage held by the Owner on the Contractor's contract.

§ 9.9 Partial Occupancy or Use

§ 9.9.1 The Owner may occupy or use any completed or partially completed portion of the Work at any stage when such portion is designated by separate agreement with the Contractor, provided such occupancy or use is consented to by the insurer and authorized by public authorities having jurisdiction over the Project. Such partial occupancy or use may commence whether or not the portion is substantially complete, provided the Owner and Contractor have accepted in writing the responsibilities assigned to each of them for payments, retainage, if any, security, maintenance, heat, utilities, damage to the Work and insurance, and have agreed in writing concerning the period for correction of the Work and commencement of warranties required by the Contract Documents. When the Contractor considers a portion substantially complete, the Contractor shall prepare and submit a list to the Architect as provided under Section 9.8.2. Consent of the Contractor to partial occupancy or use shall not be unreasonably withheld. The stage of the progress of the Work shall be determined by written agreement between the Owner and Contractor or, if no agreement is reached, by decision of the Architect.

§ 9.9.2 Immediately prior to such partial occupancy or use, the Owner, Contractor, and Architect shall jointly inspect the area to be occupied or portion of the Work to be used in order to determine and record the condition of the Work.

§ 9.9.3 Unless otherwise agreed upon, partial occupancy or use of a portion or portions of the Work shall not constitute acceptance of Work not complying with the requirements of the Contract Documents.

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§ 9.9.4 Any agreement as to the acceptance of non-conforming Work not complying with the requirements of the Contract Documents shall be in writing in the form of a Change Order, acceptable to the Owner's authorized representative and signed by all parties.

§ 9.10 Final Completion and Final Payment

§ 9.10.1 Upon receipt of the Contractor's written notice that the Work is ready for final inspection and acceptance and upon receipt of a final Application for Payment, the Architect will promptly make such inspection. When the Architect finds the Work acceptable under the Contract Documents and the Contract fully performed, the Architect will promptly issue a final Certificate for Payment stating that to the best of the Architect's knowledge, information and belief, and on the basis of the Architect's on-site visits and inspections, the Work has been completed in accordance with the Contract Documents and that the entire balance found to be due the Contractor and noted in the final Certificate is due and payable. The Architect's final Certificate for Payment will constitute a further representation that conditions listed in Section 9.10.2 as precedent to the Contractor's being entitled to final payment have been fulfilled.

§ 9.10.2 Neither final payment nor any remaining retained percentage shall become due until the Contractor submits to the Architect (1) an affidavit that payrolls, bills for materials and equipment, and other indebtedness connected with the Work for which the Owner or the Owner's property might be responsible or encumbered (less amounts withheld by Owner) have been paid or otherwise satisfied, (2) a certificate evidencing that insurance required by the Contract Documents to remain in force after final payment is currently in effect, (3) a written statement that the Contractor knows of no reason that the insurance will not be renewable to cover the period required by the Contract Documents, (4) consent of surety, if any, to final payment, (5) documentation of any special warranties, such as manufacturers' warranties or specific Subcontractor warranties, ~~and (6)~~ (6) an affidavit that states the Work is fully completed and performed in accordance with the Contract Documents, (7) in the event of Contractor bankruptcy, at the Owner's option, an order entered by the court having jurisdiction of the Contractor's insolvency proceeding authorizing such payment, (8) a general release executed by the Contractor on a form provided by the Architect, (9) all close-out documents, (10) all warranties collected and provided in an acceptable manner, and (11) if required by the Owner, other data establishing payment or satisfaction of obligations, such as receipts and releases and waivers of liens, claims, security interests, or encumbrances arising out of the Contract, to the extent and in such form as may be designated by the Owner. If a Subcontractor refuses to furnish a release or waiver required by the Owner, the Contractor may furnish a bond satisfactory to the Owner to indemnify the Owner against such lien, claim, security interest, or encumbrance. If a lien, claim, security interest, or encumbrance remains unsatisfied after payments are made, the Contractor shall refund to the Owner all money that the Owner may be compelled to pay in discharging the lien, claim, security interest, or encumbrance, including all costs and ~~reasonable~~ actual attorneys' fees.

§ 9.10.3 If, after Substantial Completion of the Work, final completion thereof is materially delayed through no fault of the Contractor or by issuance of Change Orders affecting final completion, and the Architect so confirms, the Owner shall, upon application by the Contractor and certification by the Architect, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed, corrected, and accepted. If the remaining balance for Work not fully completed or corrected is less than retainage stipulated in the Contract Documents, and if bonds have been furnished, the written consent of the surety to payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by the Contractor to the Architect prior to certification of such payment. Such payment shall be made under terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

§ 9.10.4 The making of final payment shall constitute a waiver of Claims by the Owner except those arising ~~from~~from:

.1 ~~liens, Claims, security interests, or encumbrances arising out of the Contract~~ Claims already asserted as of the date of final payment and unsettled;

.2 failure of the Work to comply with the requirements of the Contract Documents and resulting demands and Claims asserted in accordance with the Contract Documents;

.3 terms of ~~special~~ all warranties required by the Contract ~~Documents;~~ Documents or provided at law or in equity; or

.4 audits performed by the Owner, if permitted by the Contract Documents, after final payment.

§ 9.10.5 Acceptance of final payment by the Contractor, a Subcontractor, or a supplier, shall constitute a waiver of ~~claims by that payee except those previously made in writing and identified by that payee~~ all claims of the Contractor except those previously made by the Contractor in writing, including Claims pending as of the final payment date, or

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identified by the Contractor as unsettled at the time of final Application for ~~Payment.~~Payment and specifically referenced as being an exception to the waiver contained in this section.

ARTICLE 10 PROTECTION OF PERSONS AND PROPERTY

§ 10.1 Safety Precautions and Programs

The Contractor shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the performance of the Contract.

§ 10.1.1 The Contractor shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the performance of the Contract. The Contractor shall continuously maintain adequate protection of all Work from damage and shall protect the Owner's property from injury or loss. The Contractor shall make good any such damage, injury or loss at no cost to the Owner, except to the extent directly caused by agents or employees of the Owner. The Contractor shall adequately protect the Work and adjacent property as required by law, the Contract Documents, or as otherwise required, to cause no damage to the Work and adjacent property during the execution of the Work. This requirement shall also apply to structures above and below ground as conditions of the site require. The Contractor shall also provide recommendations and information to the Owner regarding (a) the assignment of responsibilities for safety precautions and programs by the Subcontractors and responsibilities for safety precautions and programs by the Subcontractors and the Owner for the safety of the Owner, and the general public; (b) temporary facilities; and (c) equipment, materials and services for common use of Subcontractors. The Contractor shall verify that the requirements and assignment of responsibilities are included in the proposed Contract Documents.

§ 10.1.2 The Contractor is solely responsible to the Owner for safety at the Project site and, accordingly, shall be solely responsible for initiating, monitoring, maintaining and supervising all safety precautions and programs in connection with the performance of the Work. The foregoing does not relieve the Subcontractors of their responsibility to the Contractor for the safe performance of their Work in accordance with all applicable laws.

§ 10.1.3 The Contractor shall develop and implement a safety plan that complies with all applicable laws covering all activities on the Project Site except those activities performed solely by the Owner. The Contractor shall provide the Owner a copy of such health and safety plan prior to commencement of Work. The Owner shall have no duty to review the plan and shall assume no duty by doing so.

§ 10.2 Safety of Persons and Property

§ 10.2.1 The Contractor shall take ~~reasonable precautions~~ every reasonable precaution for safety of, and shall provide reasonable protection to prevent damage, injury, or loss to

.1 employees on the Work and other persons who may be affected thereby;

.2 the Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody, or control of the Contractor, a Subcontractor, or a Sub-subcontractor; and

.3 other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation, or replacement in the course of construction.

§ 10.2.2 The Contractor shall ~~comply with, and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities, bearing on safety of persons or property or their protection from damage, injury, or loss.~~take all reasonable safety precautions with respect to its Work and work of others, shall comply with all standard industry safety measures and shall comply with all applicable laws, ordinances, rules, regulations and orders of any public authority and all other requirements of the Contract Documents, including those applicable to the safety of persons or property. The Contractor shall be responsible for the safety of all of the Contractor's employees and the safety of all of the Contractor's Subcontractors, suppliers, and their employees. The Contractor shall report in writing to the Architect any injury to any of Contractor's or its Subcontractor's employees at the site within one (1) day after the occurrence of such injury.

§ 10.2.3 The Contractor shall implement, erect, and maintain, as required by existing conditions and performance of the Contract, ~~reasonable~~ reasonable, necessary and appropriate safeguards for safety and protection, including posting danger signs and other warnings against hazards; promulgating safety regulations; and notifying the owners and users of adjacent sites and utilities of the safeguards.

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§ 10.2.4 When use or storage of explosives or other hazardous materials or equipment, or unusual methods are necessary for execution of the Work, the Contractor shall exercise utmost care and carry on such activities under supervision of properly qualified personnel. The Contractor shall be solely and fully responsible for any and all damage claims and for defense of all actions against the Owner relating to such explosives, hazardous materials and/or unusual methods.

§ 10.2.5 The Contractor shall promptly remedy damage and loss ~~(other than damage or loss insured under property insurance required by the Contract Documents)~~ to property referred to in Sections 10.2.1.2 and 10.2.1.3 caused in whole or in part by the Contractor, a Subcontractor, a Sub-subcontractor, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable and for which the Contractor is responsible under Sections 10.2.1.2 and 10.2.1.3. The Contractor may make a Claim for the cost to remedy the damage or loss to the extent such damage or loss is attributable to acts or omissions of the Owner or Architect or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, and not attributable to the fault or negligence of the Contractor. The foregoing obligations of the Contractor are in addition to the Contractor's obligations under Section 3.18.

§ 10.2.6 The Contractor shall designate a responsible member of the Contractor's organization at the site whose duty shall be the prevention of accidents. This person shall be the Contractor's superintendent unless otherwise designated by the Contractor in writing to the Owner and Architect.

§ 10.2.7 The Contractor shall not permit any part of the construction or site to be loaded so as to cause damage or create an unsafe condition.

§ 10.2.8 Injury or Damage to Person or Property

If ~~either party~~ the Contractor suffers injury or damage to person or property because of an act or omission of the ~~other party,~~ Owner, or of others for whose acts ~~such party~~ the Owner is legally responsible, written notice of the injury or damage, whether or not insured, shall be given to the ~~other party~~ Owner within a reasonable time not exceeding 21 days after discovery. The notice shall provide sufficient detail to enable the ~~other party to investigate the matter.~~ Owner to investigate the matter. This provision shall be for investigative purposes only and shall not eliminate or reduce a party's obligation to pursue Claims. The Contractor's failure to do so shall be an irrevocable waiver of any Claim arising out of such injury or damage. Injury or damage to persons or property suffered by the Owner because of an act or omission of the Contractor, or others for whose acts the Contractor is legally responsible, shall be subject to the limitation periods established by Michigan law.

§ 10.2.8.1 The Contractor causing damage to the Work of another shall be responsible for the repair and replacement of such damaged Work. Back charges shall be made against the Contract Sum of the damaging Contractor when corrections are not made promptly.

§ 10.2.8.2 If the Contractor or any Subcontractor chooses to use any systems, equipment, facilities, or services which have been incorporated in the Project as a permanent part thereof by any other, the Contractor shall assume full responsibility for damages caused to said systems, equipment, facilities or services, and have damages repaired as required, so that in no case will the performance of the used systems, equipment, facilities or services be diminished from the specified criteria as a result of such use.

§ 10.2.9 The Contractor acknowledges that the safety of the Owner's students, employees and guests is of the utmost importance. The Contractor will take no action which would jeopardize the safety of the Owner's students, employees and guests and, without the Owner's written approval, shall take no action which would interfere with the Owner's activities. Without limiting the foregoing sentence, the Contractor shall comply with all laws applicable to student and/or school safety.

§ 10.3 Hazardous Materials and Substances

§ 10.3.1 ~~The~~ To the extent specified in the Contract Documents, the Contractor is responsible for compliance with any requirements ~~included in the Contract Documents~~ regarding hazardous materials or substances. If the Contractor encounters a hazardous material or substance not addressed in the Contract Documents and if reasonable precautions will be inadequate to prevent foreseeable bodily injury or death to persons resulting from a material or substance, including but not limited to asbestos or polychlorinated biphenyl (PCB), encountered on the site by the Contractor, the

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Contractor shall, upon recognizing the condition, immediately stop Work in the affected area and notify the Owner and Architect in writing of the condition.

§ 10.3.2 Upon receipt of the Contractor's written notice, the Owner shall obtain the services of a licensed laboratory to verify the presence or absence of the material or substance reported by the Contractor and, in the event such material or substance is found to be present, to cause it to be rendered harmless. Unless otherwise required by the Contract Documents, the Owner shall furnish in writing to the Contractor and Architect the names and qualifications of persons or entities who are to perform tests verifying the presence or absence of the material or substance or who are to perform the task of removal or safe containment of the material or substance. ~~The Contractor and the Architect will promptly reply to the Owner in writing stating whether or not either has reasonable objection to the persons or entities proposed by the Owner. If either the Contractor or Architect has an objection to a person or entity proposed by the Owner, the Owner shall propose another to whom the Contractor and the Architect have no reasonable objection.~~ When the material or substance has been rendered harmless, Work in the affected area shall resume upon written agreement of the Owner and Contractor. By Change Order, the Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable additional ~~costs of~~ costs, as they relate to payment of staff and extended general conditions, to address shutdown, delay, and start-up.

§ 10.3.3 To the ~~fullest~~ extent permitted by law, the Owner shall indemnify and hold harmless the Contractor, Subcontractors, Architect, Architect's consultants, and agents and employees of any of them from and against claims, damages, losses, and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the Work in the affected area if in fact the material or substance presents the risk of bodily injury or death as described in Section 10.3.1 and has not been rendered harmless, provided that such claim, damage, loss, or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), except to the extent that such damage, loss, or expense is due to the fault or negligence of the party seeking indemnity.

§ 10.3.4 The Owner shall not be responsible under this Section 10.3 for hazardous materials or substances the Contractor brings to the ~~site unless such materials or substances are required by the Contract Documents. The Owner shall be responsible for hazardous materials or substances required by the Contract Documents, except to the extent of the Contractor's fault or negligence in the use and handling of such materials or substances.~~site. To the extent the Contract Documents require the removal, transport and disposal of hazardous materials, the Contractor agrees that it assumes responsibility for said tasks as part of the Contract.

§ 10.3.5 The Contractor shall reimburse the Owner for the cost and expense the Owner incurs (1) for remediation of hazardous materials or substances the Contractor brings to the site and negligently handles, or (2) where the Contractor fails to perform its obligations under Section 10.3.1, except to the extent that the cost and expense are due to the Owner's fault or negligence.

§ 10.3.6 If, without negligence or attributable fault of any kind on the part of the Contractor, the Contractor is held liable by a government agency for the cost of remediation of a hazardous material or substance solely by reason of performing Work as required by the Contract Documents, the Owner shall reimburse the Contractor for all cost and expense thereby incurred.

§ 10.4 Emergencies

In an emergency affecting safety of persons or property, the Contractor shall act, at the Contractor's reasonable discretion, to prevent threatened damage, injury, or loss. Additional compensation or extension of time claimed by the Contractor on account of an emergency shall be determined as provided in Article 15 and Article 7. Nothing in this paragraph will be construed as relieving Contractor from the cost and responsibilities for emergencies covered hereby.

§ 10.5 Notification of Utility Companies

§ 10.5.1 At least five (5) working days prior to the start of work in areas which may involve existing utility lines, the Contractor shall notify the MISS DIG notification system, as legally required and, if applicable, any Registered Utility Protection Service of the utility company possibly affected by the planned work by certified mail with return receipt requested.

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§ 10.5.2 The utility company should, upon receipt of notice, stake, mark or otherwise designate the location (and depth) of their lines, or temporarily move the line(s). The Contractor shall wait for the applicable utility to stake and/or mark its utility lines before commencing the relevant Work

§ 10.5.3 The Contractor shall immediately report to the respective utility company any break or leak in its lines, or any dent, gouge, groove or other damage to the utility line or to its coating or cathodic protection made or discovered in the course of the Work.

§ 10.5.4 The Contractor shall immediately alert the Owner, Architect and occupants of nearby premises of any and all emergencies caused or discovered in the utility line(s) in the course of the Work.

§ 10.6 Security

§ 10.6.1 All construction participants, including the Contractor, Architect, Subcontractors, etc., shall cooperate with the Owner's security personnel and shall comply with all of the Owner's security requirements. Such requirements shall include, without limitation, if requested by the Owner, delivering to the Owner's security personnel, prior to the commencement of the Work on each day, a list of all personnel who will be permitted access to the Work. The foregoing, however, shall not relieve the Contractor of any obligation to provide a safe and secure workplace for all parties entering the Project Site. The Contractor shall be responsible to implement commercially reasonable data security protection measures to protect the Owner's networks and data when performing technology-related Work.

§ 10.7 Fire Protection

§ 10.7.1 The Contractor shall maintain free access to the building areas for firefighting equipment and shall at no time block off main roadways or fire aisles without providing adequate auxiliary roadways and means of entrance for firefighting equipment, including heavy fire department trucks, where applicable.

§ 10.7.2 The Contractor shall at all times cooperate with the Owner and kept the municipal fire department informed of the means of entrance and changes to the roadways or fire aisles as needed to provide fire department access to or around the Project Site.

§ 10.7.3 The Contractor shall, during the entire construction period and until the completion of the Work, provide and maintain all material, equipment, and services necessary for an adequate fire protection system, which shall meet the approval of the Owner and/or the Architect. The system shall, at a minimum, meet the requirements set forth in the Contract Documents and of applicable laws. These requirements shall be augmented and/or the installations relocated, as may be necessary to meet, at all time, the demands of adequate protection in all areas and shall not be reduced prior to the completion of the Work with the written approval of the Owner and/or the Architect.

§ 10.8 Environmental Statement and Responsibility of Contractors and Sub-Contractors

§ 10.8.1 It shall be the responsibility of the Contractor to pay any and all costs incurred in any way related to clean up related to any environmental hazard created by means of release, spill, leak or any other means of contamination caused by accident or negligence that is the responsibility of Contractor or its subcontractors or other agents.

§ 10.8.2 It shall be the responsibility of the Contractor to dispose of any product(s) and/or material in strict compliance with applicable federal, state, and local laws (e.g., Environmental Protection Agency, Michigan Department of Natural Resources, etc.).

ARTICLE 11 INSURANCE AND BONDS

§ 11.1 Contractor's Insurance and Bonds

§ 11.1.1 The Contractor shall purchase and maintain insurance of the types and limits of liability, containing the endorsements, and subject to the terms and conditions, as required by law and as otherwise described in the Agreement or elsewhere in the Contract Documents. The Contractor shall purchase and maintain the required insurance from an insurance company or insurance companies rated A- or better by A.M. Best Company and lawfully authorized to issue insurance in the jurisdiction where the Project is located. The Owner, Architect, and Architect's consultants shall be named as additional insureds under the Contractor's commercial general liability policy or as otherwise described in the Contract Documents.

§ 11.1.2 The ~~Contractor shall provide surety bonds of the types, for such penal sums, and subject to such terms and conditions as required by the Contract Documents.~~ Owner hereby requires the Contractor to furnish bonds covering

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faithful performance of the Contract and payment of obligations arising thereunder, each in the penal sum of 100% of the Contract Sum and in accordance with applicable law, on the date of execution of the Contract. The Owner may also require, through the Contract Documents or otherwise, that any contract valued at $50,000 or less shall also include payment and performance bonds each in the penal sum of up to 100% of the Contract Sum. The Contractor shall purchase and maintain the required bonds from a company or companies lawfully authorized to issue surety bonds in the jurisdiction where the Project is located. The Contractor shall obtain and provide to the Owner copies of any and all bonds required by the Contract prior to Contractor beginning performance pursuant to the Contract. The Contractor's obligation to provide such bonds shall not be waived in any fashion, including any failure to secure such bonds prior to Contractor beginning performance pursuant to the Agreement.

§ 11.1.2.1 The Contractor's liability insurance shall be not less than the following:

.1	General Requirements		
	a. Worker's Compensation	-	Statutory
	b. Employer's Liability	-	$1,000,000 Each Accident
		-	$1,000,000 Each Employee
		-	$1,000,000 Policy Limit
.2	Comprehensive General Liability		
	a. Bodily Injury	-	$1,000,000 Each Occurrence
		-	$2,000,000 Aggregate
	b. Personal Injury	-	$1,000,000 Each Occurrence
		-	$2,000,000 Aggregate
.3	Automobile Liability		
	a. Bodily Injury	-	$1,000,000 Each Person
		-	$1,000,000 Each Occurrence
	b. Property Damage	-	$1,000,000 Each Occurrence
.4	Independent Contractors	-	$1,000,000 Each Occurrence
.5	Products and Complete Operations	-	$1,000,000 for one (1) year, commencing with issuance of final Certificate for Payment
.6	Contractual Liability	-	$1,000,000 Each Occurrence
.7	Asbestos Abatement Liability	-	$1,000,000 Per Claim
		-	$2,000,000 Aggregate
.8	Pollution	-	$1,000,000
.9	Umbrella Coverage	-	$4,000,000

§ 11.1.3 Upon the request of any person or entity appearing to be a potential beneficiary of bonds covering payment of obligations arising under the Contract, the Contractor shall promptly furnish a copy of the bonds or shall authorize a copy to be furnished.

§ 11.1.4 ~~Notice of Cancellation or Expiration of Contractor's Required Insurance.~~ ~~Within three (3) business days of the date the Contractor becomes aware of an impending or actual cancellation or expiration of any insurance required by the Contract Documents, the Contractor shall provide notice to the Owner of such impending or actual cancellation or expiration. Upon receipt of notice from the Contractor, the Owner shall, unless the lapse in coverage arises from an act or omission of the Owner, have the right to stop the Work until the lapse in coverage has been cured by the procurement of replacement coverage by the Contractor. The furnishing of notice by the Contractor shall not relieve the Contractor of any contractual obligation to provide any required coverage.~~For all insurances for which the Contractor is obligated to have its insurance company name the Owner, Architect and Architect's consultants as additional insured, the Contractor shall require such insurance company to add to the policy the following clause: "The insurance afforded to the Additional Insured is primary insurance. If the Additional Insureds have other insurance which is applicable to the loss on an excess or contingent basis, the amount of the insurance company's liability under this policy shall not be reduced by the existence of such other insurance." Insurances provided on a "claims-made" basis shall be enforceable upon commencement of services and maintained for six years following substantial completion. Insurances provided on an "occurrence" basis shall be enforceable upon commencement of services and maintained for one year following substantial completion. Should the Contractor's insurance costs increase due to adding the Architect and/or Architect's Consultants as additional insureds, and should such costs be passed on to the Owner, the Architect and Architect's Consultants, as applicable, shall reimburse the Owner for such additional costs.

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§ 11.1.5 Notice of Cancellation or Expiration of Contractor's Required Insurance. Immediately after the Contractor becomes aware of an impending or actual cancellation or expiration of any insurance required by the Contract Documents, but in no event less than the sooner of three (3) days after becoming aware or the coverage actually lapsing, the Contractor shall provide notice to the Owner of such impending or actual cancellation or expiration, including the Contractor's plan to immediately procure replacement insurance as required by the Contract Documents to avoid any lapse in coverage. Contractor's failure to do so is a material breach of this Agreement, shall entitle the Owner to purchase replacement insurance at Contractor's sole cost, and shall subject the Contractor to any and all damages related to its failure to comply with its required insurance obligations. Further, upon receipt of notice from the Contractor, the Owner shall, unless the lapse in coverage arises from an act or omission of the Owner, have the right, but not the obligation, to stop the Work until the lapse in coverage has been cured by the procurement of replacement coverage by the Contractor. The furnishing of notice by the Contractor shall not relieve the Contractor of any contractual obligation to provide any required coverage.

§ 11.2 Owner's Insurance

§ 11.2.1 The Owner shall purchase and maintain insurance of the types and limits of liability, containing the endorsements, and subject to the terms and conditions, as described in the Agreement or elsewhere in the Contract Documents. The Owner shall purchase and maintain the required insurance from an insurance company or insurance companies lawfully authorized to issue insurance in the jurisdiction where the Project is located. This policy will exclude any tools, equipment, scaffolding, glass breakage, etc., owned or rented by the Contractor or Subcontractors and materials stored on the site, but not incorporated into the Project. The Contractor shall be responsible for protecting all product until the Date of Final Completion is established by the Architect/Engineer. The Contractor shall replace any Work if damaged before Final Completion. The Contractor may assume the risk itself or obtain insurance in amounts it deems sufficient.

§ 11.2.2 Failure to Purchase Required Property Insurance. If the Owner fails to purchase and maintain the required property insurance, with all of the coverages and in the amounts described in the Agreement or elsewhere in the Contract Documents, the Owner shall inform the Contractor in writing prior to commencement of the Work. Upon receipt of notice from the Owner, the Contractor may ~~delay commencement of the Work and may obtain insurance~~ obtain insurance of reasonable type and coverage amount that will protect the interests of the Contractor, Subcontractors, and Sub-Subcontractors in the ~~Work. When the failure to provide coverage has been cured or resolved, the Contract Sum and Contract Time shall be equitably adjusted. In the event the Owner fails to procure coverage, the Owner waives all rights against the Contractor, Subcontractors, and Sub-subcontractors to the extent the loss to the Owner would have been covered by the insurance to have been procured by the Owner. The cost of the insurance shall be charged to the Owner by a Change Order. If the Owner does not provide written notice, and the Contractor is damaged by the failure or neglect of the Owner to purchase or maintain the required insurance, the Owner shall reimburse the Contractor for all reasonable costs and damages attributable thereto.~~Work and the parties shall negotiate an adjustment to the Contract Sum and Contract Time. Property Insurance provided by the Owner will cover only Work incorporated into the construction and will not cover tools, equipment, or other property owned, leased, rented, or borrowed by the Contractor, Subcontractor, Sub-Subcontractor, or others.

§ 11.2.3 Notice of Cancellation or Expiration of Owner's Required Property Insurance. Within three (3) business days of the date the Owner becomes aware of an impending or actual cancellation or expiration of any property insurance required by the Contract Documents, the Owner shall provide notice to the Contractor of such impending or actual cancellation or expiration. Unless the lapse in coverage arises from an act or omission of the Contractor: (1) the Contractor, upon receipt of notice from the Owner, shall have the right to stop the Work until the lapse in coverage has been cured by the procurement of replacement coverage by either the Owner or the ~~Contractor;~~ Contractor and (2) the Contract Time and Contract Sum shall be ~~equitably adjusted; and (3) the Owner waives all rights against the Contractor, Subcontractors, and Sub-subcontractors to the extent any loss to the Owner would have been covered by the insurance had it not expired or been cancelled.~~ negotiated. If the Contractor purchases replacement coverage, the cost of the insurance shall be charged to the Owner by an appropriate Change Order. The furnishing of notice by the Owner shall not relieve the Owner of any contractual obligation to provide required insurance.

§ 11.3 Waivers of Subrogation

§ 11.3.1 ~~The Owner and Contractor waive all rights against (1) each other and any of their subcontractors, sub-subcontractors, agents, and employees, each of the other; (2) the Architect and Architect's consultants; and (3) Separate Contractors, if any, and any of their subcontractors, sub-subcontractors, agents, and employees, for damages~~

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~~caused by fire, or other causes of loss, to the extent those losses are covered by property insurance required by the Agreement or other property insurance applicable to the Project, except such rights as they have to proceeds of such insurance. The Owner or Contractor, as appropriate, shall require similar written waivers in favor of the individuals and entities identified above from the Architect, Architect's consultants, Separate Contractors, subcontractors, and sub-subcontractors. The policies of insurance purchased and maintained by each person or entity agreeing to waive claims pursuant to this section 11.3.1 shall not prohibit this waiver of subrogation. This waiver of subrogation shall be effective as to a person or entity (1) even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, (2) even though that person or entity did not pay the insurance premium directly or indirectly, or (3) whether or not the person or entity had an insurable interest in the damaged property.~~All parties referenced in this General Conditions or otherwise related to this Project acknowledge and agree that the Owner is not waiving any rights its insurer(s) may have to subrogation. To the extent any term in the Contract Documents contrary to this provision, such term is void and unenforceable.

§ 11.3.2 ~~If during the Project construction period the Owner insures properties, real or personal or both, at or adjacent to the site by property insurance under policies separate from those insuring the Project, or if after final payment property insurance is to be provided on the completed Project through a policy or policies other than those insuring the Project during the construction period, to the extent permissible by such policies, the Owner waives all rights in accordance with the terms of Section 11.3.1 for damages caused by fire or other causes of loss covered by this separate property insurance.~~**NOT USED.**

§ 11.4 Loss of Use, Business Interruption, and Delay in Completion Insurance

The Owner, at the Owner's option, may purchase and maintain insurance that will protect the Owner against loss of use of the Owner's property, or the inability to conduct normal operations, due to fire or other causes of loss.~~The Owner waives all rights of action against the Contractor and Architect for loss of use of the Owner's property, due to fire or other hazards however caused.~~

~~**§11.5 Adjustment and Settlement of Insured Loss**~~
§ 11.5 Adjustment and Settlement of Insured Loss

§ 11.5.1 A loss insured under the property insurance required by the Agreement shall be adjusted by the Owner as fiduciary and made payable to the Owner as fiduciary for the insureds, as their interests may appear, subject to requirements of any applicable mortgagee clause and of Section 11.5.2. The Owner shall pay the Architect and Contractor their just shares of insurance proceeds received by the Owner, and by appropriate agreements the Architect and Contractor shall make payments to their consultants and Subcontractors in similar manner. The Owner shall use its best efforts, with consultation of the Architect, to reach a quick and fair settlement for all interested parties, with the insurance companies after a loss.

§ 11.5.2 Prior to settlement of an insured loss, the Owner shall notify the Contractor of the terms of the proposed settlement as well as the proposed allocation of the insurance proceeds. The Contractor shall have 14 days from receipt of notice to object to the proposed settlement or allocation of the proceeds. If the Contractor does not object, the Owner shall settle the loss and the Contractor shall be bound by the settlement and allocation. Upon receipt, the Owner shall deposit the insurance proceeds in a separate account and make the appropriate distributions. Thereafter, if no other agreement is made or the Owner does not terminate the Contract for convenience, the Owner and Contractor shall execute a Change Order for reconstruction of the damaged or destroyed Work in the amount allocated for that purpose. If the Contractor timely objects to either the terms of the proposed settlement or the allocation of the proceeds, the Owner may proceed to settle the insured loss, and any dispute between the Owner and Contractor arising out of the settlement or allocation of the proceeds shall be resolved pursuant to Article ~~15.~~15 if the Contractor timely and properly files a claim under Article 15.. Pending resolution of any dispute, the Owner may issue a Construction Change Directive for the reconstruction of the damaged or destroyed Work.

ARTICLE 12 UNCOVERING AND CORRECTION OF WORK

§ 12.1 Uncovering of Work

§ 12.1.1 If a portion of the Work is covered contrary to the Architect's request or to requirements specifically expressed in the Contract Documents, it must, if requested in writing by the Architect, be uncovered for the Architect's examination and be replaced at the Contractor's expense without change in the Contract ~~Time.~~Time or Contract Sum.

§ 12.1.2 If a portion of the Work has been covered that the Architect has not specifically requested to examine prior to its being covered, the Architect may request with the Owner's consent to see such Work and it shall be uncovered by

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the Contractor. If such Work is in accordance with the Contract Documents, the Contractor shall be entitled to ~~an equitable~~ a negotiated adjustment to the Contract Sum and Contract Time as may be appropriate. At the time the Owner's consent is sought as described herein, the Architect shall notify the Owner that additional costs may apply if the Work is in accordance with the Contract Documents. If such Work is not in accordance with the Contract Documents, the costs of uncovering the Work, and the cost of correction, shall be at the Contractor's expense.

§ 12.2 Correction of Work

It is understood that the correction of work, either before or after Substantial Completion, shall occur without extension of the Contract Time, without increase in the Contract Sum, and without use of any contingency, unless the need for corrections is due to acts of the Owner, Architect, or others who are acting under the Owner's control.

§ 12.2.1 Before Substantial Completion

The Contractor shall promptly correct Work rejected by the Architect or failing to conform to the requirements of the Contract Documents, discovered before Substantial Completion and whether or not fabricated, installed or completed. Costs of correcting such rejected Work, including work of other Contractors and Subcontractors, compensation of consultants, any delay or related damages, attorneys' fees incurred by the Owner, additional testing and inspections, the cost of uncovering and replacement, and compensation for the Architect's services and expenses made necessary thereby, shall be at the Contractor's expense. The Owner shall have the right to charge the Contractor for any such costs and expenses and to deduct such amounts from any future payments due the Contractor.

§ 12.2.2 After Substantial Completion

§ 12.2.2.1 In addition to the Contractor's obligations under Section 3.5, if, within one year after the date of Substantial Completion of the Work or designated portion thereof or after the date for commencement of warranties established under Section 9.9.1, or by terms of any applicable special warranty required by the Contract Documents, any of the Work is found to be not in accordance with the requirements of the Contract Documents, the Contractor shall correct it promptly after receipt of notice from the Owner to do so, unless the Owner has previously given the Contractor a written acceptance of such condition. The Owner shall give such notice promptly after discovery of the condition. ~~During the one-year period for correction of Work, if the Owner fails to notify the Contractor and give the Contractor an opportunity to make the correction, the Owner waives the rights to require correction by the Contractor and to make a claim for breach of warranty.~~ If the Contractor fails to correct nonconforming Work within a reasonable time during that period after receipt of notice from the Owner or Architect, the Owner may correct it in accordance with Section 2.5.

§ 12.2.2.2 The one-year period for correction of Work shall be extended with respect to portions of Work first performed after Substantial Completion by the period of time between Substantial Completion and the actual completion of that portion of the Work.

§ 12.2.2.3 The one-year period for correction of Work shall not be extended by corrective Work performed by the Contractor pursuant to this Section 12.2.

§ 12.2.3 The Contractor shall remove from the site portions of the Work that are not in accordance with the requirements of the Contract Documents and are neither corrected by the Contractor nor accepted by the Owner.

§ 12.2.4 The Contractor shall bear the cost of correcting destroyed or damaged construction of the Owner or Separate Contractors, whether completed or partially completed, caused by the Contractor's correction or removal of Work that is not in accordance with the requirements of the Contract Documents.

§ 12.2.5 Nothing contained in this Section 12.2 or other provisions of the Contract Documents establishing a "correction warranty" or other similar concept shall be construed to establish a period of limitation with respect to other obligations the Contractor has under the Contract ~~Documents.~~ Documents, including, without limitation, Section 3.5. Establishment of the one-year period for correction of Work as described in Section 12.2.2 relates only to the specific obligation of the Contractor to correct the Work, and has no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to the Contractor's obligations other than specifically to correct the Work.

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§ 12.2.6 The Contractor shall respond immediately to correct Work deficiencies and/or punch list items. Failure to correct Work deficiencies and/or punch list items in a timely fashion shall be a substantial breach, and the Owner may terminate the Contract immediately. The Owner's right of termination in this Section 12.2.6 is separate and distinct from the right of termination in Section 14.2. Whether or not the Contract is terminated, if the Contractor fails to make corrections in a timely fashion, such Work may be corrected by the Owner, in its sole discretion, at the Contractor's expense and the Contract Sum may be adjusted by back charge and/or withholding future payments due the Contractor accordingly. The Contractor shall promptly notify the Architect in writing when Work deficiencies and/or punch list items are completed. If upon review of the Work by the Architect, after such notification by the Contractor, Work deficiencies and/or punch list items shall continue to exist, the Contractor shall reimburse the Owner for any costs incurred by the Owner, plus ten percent (10%) overhead and profit, as well as the Architect's fees for reinspections of the Work.

§ 12.3 Acceptance of Nonconforming Work

If the Owner prefers to accept Work that is not in accordance with the requirements of the Contract Documents, the Owner may do so instead of requiring its removal and correction, in which case the Contract Sum will be reduced as appropriate and equitable. Such adjustment shall be effected whether or not final payment has been made. The acceptance of nonconforming Work by the Owner shall be by written Change Order signed by the Owner's authorized representative. Acceptance of nonconforming Work may only occur pursuant to such written Change Order.

ARTICLE 13 MISCELLANEOUS PROVISIONS

§ 13.1 Governing Law

The Contract shall be governed by the law of the ~~place where the Project is located, excluding that jurisdiction's choice of law rules. If the parties have selected arbitration as the method of binding dispute resolution, the Federal Arbitration Act shall govern Section 15.4.~~State of Michigan in all respects, except that Claims and causes of action for breach of the Contract Documents brought by the Owner shall not be deemed untimely if filed within six (6) years of Substantial Completion of the entire Project.

§ 13.2 Successors and Assigns

§ 13.2.1 The Owner and Contractor respectively bind themselves, their partners, successors, assigns, and legal representatives to covenants, agreements, and obligations contained in the Contract Documents. Except as provided in Section 13.2.2, neither party to the Contract shall assign the Contract as a whole without written consent of the other. If either party attempts to make an assignment without such consent, that party shall nevertheless remain legally responsible for all obligations under the Contract.

§ 13.2.2 The Owner may, without consent of the Contractor, assign the Contract to a lender providing construction financing for the Project, if the lender assumes the Owner's rights and obligations under the Contract Documents. The Contractor shall execute all consents reasonably required to facilitate the assignment.

§ 13.3 Rights and Remedies

§ 13.3.1 Duties and obligations imposed by the Contract Documents and rights and remedies available thereunder shall be in addition to and not a limitation of duties, obligations, rights, and remedies otherwise imposed or available by law.

§ 13.3.2 No action or failure to act by the Owner, Architect, or Contractor shall constitute a waiver of a right or duty afforded them under the Contract, nor shall such action or failure to act constitute approval of or acquiescence in a breach thereunder, except as may be specifically agreed upon in writing.

§ 13.4 Tests and Inspections

§ 13.4.1 Tests, inspections, and approvals of portions of the Work shall be made as required by the Contract Documents and by applicable laws, statutes, ordinances, codes, rules, and regulations or lawful orders of public authorities. Unless otherwise provided, the Contractor shall make arrangements for such tests, inspections, and approvals with an independent testing laboratory or entity acceptable to the Owner, or with the appropriate public authority, and shall bear all related costs of tests, inspections, and approvals. The Contractor shall give the Architect timely notice of when and where tests and inspections are to be made so that the Architect may be present for such procedures. The Owner shall bear costs of tests, inspections, or approvals that do not become requirements until after bids are received or negotiations concluded. The ~~Owner~~ Contractor shall directly arrange and pay for tests, inspections, or approvals where building codes or applicable laws or regulations so require.

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§ 13.4.2 If the Architect, Owner, or public authorities having jurisdiction determine that portions of the Work require additional testing, inspection, or approval not included under Section 13.4.1, the Architect will, upon written authorization from the Owner, instruct the Contractor to make arrangements for such additional testing, inspection, or approval, by an entity acceptable to the Owner, and the Contractor shall give timely notice to the Architect of when and where tests and inspections are to be made so that the Architect may be present for such procedures. Such costs, except as provided in Section 13.4.3, shall be at the Owner's expense.

§ 13.4.3 If procedures for testing, inspection, or approval under Sections 13.4.1 and 13.4.2 reveal failure of the portions of the Work to comply with requirements established by the Contract ~~Documents,~~ Documents or applicable law, all costs made necessary by such failure, including those of repeated procedures and compensation for the Architect's services and expenses, shall be at the Contractor's expense.

§ 13.4.4 Required certificates of testing, inspection, or approval shall, unless otherwise required by the Contract Documents, be secured by the Contractor and promptly delivered to the Architect.

§ 13.4.5 If the Architect is to observe tests, inspections, or approvals required by the Contract Documents, the Architect will do so promptly and, where practicable, at the normal place of testing.

§ 13.4.6 Tests or inspections conducted pursuant to the Contract Documents shall be made promptly to avoid unreasonable delay in the Work.

§ 13.5 Interest

Payments due and unpaid under the Contract Documents shall bear interest from the date payment is due at the rate the parties agree upon in writing or, in the absence thereof, at the legal rate prevailing from time to time at the place where the Project is located. For any late payments by the Owner, the interest rate shall not exceed five percent (5%) per annum (see MCL 438.31).

ARTICLE 14 TERMINATION OR SUSPENSION OF THE CONTRACT

§ 14.1 Termination by the Contractor

§ 14.1.1 The Contractor may terminate the Contract if the Work is stopped for a period of 30 consecutive days for reasons within the Owner's control and through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, their agents or employees, or any other persons or entities performing portions of the Work, for any of the following reasons:

.1 Issuance of an order of a court or other public authority having jurisdiction that requires all Work to be stopped;

.2 ~~An act of government, such as a declaration of national emergency, that requires all Work to be stopped;~~

.3 Because the ~~Architect has not issued a Certificate for Payment and has not notified the Contractor of the reason for withholding certification as provided in Section 9.4.1, or because the~~ Owner has not made payment on ~~a~~ an undisputed Certificate for Payment within the time stated in the Contract Documents, subject to justifiable withholding of payment as described herein or in the Contract Documents; or

.4 The Owner has failed to furnish to the Contractor reasonable evidence as required by Section 2.2.

§ 14.1.2 The Contractor may terminate the Contract if, through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, their agents or employees, or any other persons or entities performing portions of the Work, repeated suspensions, delays, or interruptions of the entire Work by the Owner as described in Section 14.3, constitute in the aggregate more than 100 percent of the total number of days scheduled for completion, or 120 days in any 365-day period, whichever is less.

§ 14.1.3 If one of the reasons described in Section 14.1.1 or 14.1.2 exists, the Contractor may, upon seven days' written notice to the Owner and Architect, terminate the Contract and recover from the Owner payment for Work executed, as well as reasonable overhead and profit on Work not executed, and costs incurred by reason of such termination.

§ 14.1.4 If the Work is stopped for a period of 60 consecutive days for reasons within the Owner's control and through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, or their agents or employees or any other

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persons or entities performing portions of the Work because the Owner has repeatedly failed to fulfill the Owner's obligations under the Contract Documents with respect to matters important to the progress of the Work, the Contractor may, upon seven additional days' written notice to the Owner and the Architect, terminate the Contract and recover from the Owner as provided in Section 14.1.3.

§ 14.2 Termination by the Owner for Cause

§ 14.2.1 The Owner may terminate the Contract if the Contractor

.1 ~~repeatedly~~ refuses or fails to supply enough properly skilled workers or proper ~~materials;~~materials to the point of negatively impacting the Project and/or the related schedule;

.2 fails to make payment to Subcontractors or suppliers in accordance with the respective agreements between the Contractor and the Subcontractors or suppliers;

.3 ~~repeatedly~~ disregards applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of a public authority;~~or~~

.4 otherwise is guilty of substantial breach of a provision of the Contract ~~Documents.~~Documents; or

.5 the Contractor fails to prosecute the Work or any part thereof with promptness and diligence or goes into bankruptcy, liquidation, makes an assignment for the benefit of creditors, enters into a composition with its creditors, or becomes insolvent.

§ 14.2.2 When any of the reasons described in Section 14.2.1 exist, and upon certification by the Architect that sufficient cause exists to justify such action, the Owner may, without prejudice to any other rights or remedies of the Owner and after giving the Contractor and the Contractor's surety, if any, ~~seven days' notice, terminate employment of the Contractor and may, subject to any prior rights of the surety:~~three (3) business days' notice, terminate the Contractor's right to proceed with the Work, or such part of the Work as to which such defaults have occurred, and may take any one or more of the following actions:

.1 Exclude the Contractor from the site and take possession of all materials, equipment, tools, and construction equipment and machinery thereon owned by the Contractor;

.2 Accept assignment of subcontracts pursuant to Section 5.4; and

.3 Finish the Work by whatever reasonable method the Owner may deem expedient. Upon written request of the Contractor, the Owner shall furnish to the Contractor a detailed accounting of the costs incurred by the Owner in finishing the Work.

In the event the Contractor's surety bond requires notice of intent to declare a default of the Contractor and if such bond notice is provided by the Owner, such notice shall be adequate to satisfy the three (3) day written notice described above in this Section.

The three (3) day notice period identified in this Section does not give rise to an opportunity for the Contractor to cure the cause for termination. Further, the Owner's failure to properly follow the termination procedure shall not be a substantial or material breach of the Contract or the Owner's obligations.

§ 14.2.3 When the Owner terminates the Contract for one of the reasons stated in Section 14.2.1, the Contractor shall not be entitled to receive further payment until the Work is finished.

§ 14.2.4 If the unpaid balance of the Contract Sum exceeds costs of finishing the Work, including compensation for the Architect's services and expenses made necessary thereby, and other damages incurred by the Owner in pursuing termination and completion of the Work, including actual attorney and legal fees and costs, and not expressly waived, such excess shall be paid to the Contractor. If such costs and damages exceed the unpaid balance, the Contractor shall pay the difference to the Owner. The amount to be paid to the Contractor or Owner, as the case may be, shall be certified by the Initial Decision Maker, upon application, and this obligation for payment shall survive termination of the Contract.

§ 14.3 Suspension by the Owner for Convenience

§ 14.3.1 The Owner may, without cause, order the Contractor in writing to suspend, delay or interrupt the Work, in whole or in part for such period of time as the Owner may determine.

§ 14.3.2 The Contract Sum and Contract Time shall be adjusted for increases in the cost and time caused by suspension, delay, or interruption under Section 14.3.1. Adjustment of the Contract Sum shall include profit. No adjustment shall be made to the extent

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.1 that performance is, was, or would have been, so suspended, delayed, or interrupted, by another cause for which the Contractor is responsible; or

.2 that an equitable adjustment is made or denied under another provision of the Contract.

§ 14.4 Termination by the Owner for Convenience

§ 14.4.1 The Owner may, at any time, terminate the Contract for the Owner's convenience and without cause.

§ 14.4.2 Upon receipt of notice from the Owner of such termination for the Owner's convenience, the Contractor shall

.1 cease operations as directed by the Owner in the notice;

.2 take actions necessary, or that the Owner may direct, for the protection and preservation of the Work; and

.3 except for Work directed to be performed prior to the effective date of termination stated in the notice, terminate all existing subcontracts and purchase orders and enter into no further subcontracts and purchase orders.

§ 14.4.3 In case of such termination for the Owner's convenience, the Owner shall pay the Contractor for Work properly ~~executed;~~ executed and costs incurred by reason of the ~~termination, including costs attributable to termination of Subcontracts; and the termination fee, if any, set forth in the Agreement.~~termination.

ARTICLE 15 CLAIMS AND DISPUTES

§ 15.1 Claims

§ 15.1.1 Definition

A Claim is a demand or assertion by one of the parties seeking, as a matter of right, payment of money, a change in the Contract Time, or other relief with respect to the terms of the ~~Contract.~~ Contract, including, but not limited to, additional sums, additional time for performance, or damages for delay. The term "Claim" also includes other disputes and matters in question between the Owner and Contractor arising out of or relating to the Contract. The responsibility to substantiate Claims shall rest with the party making the Claim. This Section 15.1.1 does not require the Owner to file a Claim in order to impose liquidated damages in accordance with the Contract Documents. The Contractor shall not knowingly (as "knowingly" is defined in the Federal False Claims Act, 31 USC 3729, *et seq.*) present or cause to be presented a false or fraudulent Claim. As a condition precedent to making a Claim by the Contractor, the Claim shall be accompanied by an affidavit sworn to before a notary public or other person authorized to administer oaths in the State of Michigan and executed by an authorized representative of the Contractor, which states that, "The Claim which is submitted herewith complies with subparagraph 15.1.1 of the General Conditions, as amended, which provides that the Contractor shall not knowingly present or cause to be presented a false or fraudulent claim." Claims of the Owner shall be governed by the relevant Michigan statutory limitations period, excepting Warranty claims which shall be controlled by the warranty documents.

§ 15.1.2 Time Limits on Claims

The Owner and Contractor shall commence all Claims as set forth herein and subject to law and shall pursue all causes of action against the other and arising out of or related to the Contract, whether in contract, tort, breach of warranty or otherwise, in accordance with the requirements of the binding dispute resolution method selected in the Agreement and within the period specified by applicable law, but in any case not more than 10 years after the date of Substantial Completion of the Work. The Owner and Contractor waive all Claims and causes of action not commenced in accordance with this Section 15.1.2. The Owner shall commence all claims and causes of action in accordance with Section 13.1 and Section 15.1.2.1, regardless of any other time frames identified in the Contract Documents. The Contractor shall commence all Claims and causes of action in accordance with Section 15.1.2 and Section 15.1.3, other provisions of the Contract, and in accordance with Michigan law.

§ 15.1.2.1 Regardless of any provisions to the contrary, the limitations period with respect to any Claim or cause of action by the Owner with respect to defective or nonconforming Work shall not commence until the discovery of such defective or nonconforming Work by the Owner. See also Section 13.1.

§ 15.1.2.2 Surety Notice and Prior Approval

Except where otherwise expressly required by the terms of the Agreement or the General Conditions, exercise by the Owner of any contractual or legal right or remedy without prior notice to or approval by the Contractor's surety shall in no way prohibit the Owner's ability to pursue such right or remedy. Further, pursuit of such a right or remedy

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without prior notice to or approval of surety shall in no way compromise, limit or bar any claim by the Owner against a surety bond of the Contractor.

§ 15.1.3 Notice of Claims

§ 15.1.3.1 Claims by ~~either~~ the ~~Owner or~~ Contractor, where the condition giving rise to the Claim is first discovered prior to expiration of the period for correction of the Work set forth in Section 12.2.2, shall be initiated by notice to the ~~other party~~ Owner and to the Initial Decision Maker with a copy sent to the Architect, if the Architect is not serving as the Initial Decision Maker. Claims by ~~either party under this Section 15.1.3.1~~ the Contractor shall be initiated within 21 days after occurrence of the event giving rise to such Claim or within 21 days after the ~~claimant~~ Contractor first recognizes the condition giving rise to the Claim, whichever is later. The Contractor's failure to timely and properly initiate a Claim shall be an absolute and irrevocable waiver of such Claim and any cause of action. Claims and causes of action by the Owner shall be governed by the applicable statute of limitations period. The parties acknowledge, understand, and agree that the Contractor's required prompt filing of a Claim is critical to the Project, as Contractor Claims often affect the Project schedule and/or Project budget, and that the deadline and waiver applicable to Contractor Claims is a material inducement to the Owner entering into an agreement with the Contractor.

§ 15.1.3.2 ~~Claims by either the Owner or Contractor, where the condition giving rise to the Claim is first discovered after expiration of the period for correction of the Work set forth in Section 12.2.2, shall be initiated by notice to the other party. In such event, no decision by the Initial Decision Maker is required.~~**NOT USED.**

§ 15.1.4 Continuing Contract Performance

§ 15.1.4.1 Pending final resolution of a ~~Claim,~~ Claim or cause of action, including mediation, arbitration and/or litigation, as applicable, except as otherwise agreed in writing or as provided in Section 9.7 and Article 14, the Contractor shall proceed diligently with performance of the Contract and the Owner shall continue to make undisputed payments in accordance with the Contract Documents.

§ 15.1.4.2 ~~The Contract Sum and Contract Time shall be adjusted in accordance with the Initial Decision Maker's decision, subject to the right of either party to proceed in accordance with this Article 15. The Architect will issue Certificates for Payment in accordance with the decision of the Initial Decision Maker.~~**NOT USED.**

§ 15.1.5 Claims for Additional Cost

If the Contractor wishes to make a Claim for an increase in the Contract Sum, written notice as provided in Section 15.1.3 shall be given before proceeding to execute the portion of the Work that is the subject of the Claim. Failure to provide such notice shall serve as an absolute bar against a Claim or cause of action for such an increase in the Contract Sum. Prior notice is not required for Claims relating to an emergency endangering life or property arising under Section 10.4. A Project delay shall not be a basis for a Claim or cause of action for additional cost by the Contractor, except for costs related to payment of staff and extended general conditions.

§ 15.1.6 Claims for Additional Time

§ 15.1.6.1 If the Contractor wishes to make a Claim for an increase in the Contract Time, written notice as provided in Section 15.1.3 shall be given. The Contractor's Claim shall include an estimate of cost and of probable effect of delay on progress of ~~the Work.~~ the Work due to the increase in Contract Time and allowable costs (e.g., payment of staff and general conditions) sought. In the case of a continuing delay, only one Claim is necessary.

§ 15.1.6.2 If adverse weather conditions are the basis for a Claim for additional time, such Claim shall be documented by data substantiating that weather conditions were abnormal for the period of time, could not have been reasonably anticipated, and had an adverse effect on the scheduled construction.

§ 15.1.7 Waiver of Claims for Consequential Damages

~~The~~ As permitted by law, the Contractor and Owner waive Claims and/or causes of action against each other for consequential damages arising out of or relating to this Contract. This mutual waiver includes

.1 damages incurred by the Owner for rental expenses, for losses of use, income, profit, financing, business and reputation, and for loss of management or employee productivity or of the services of such persons; and

.2 , without limitation damages incurred by the Contractor for principal office expenses including the compensation of personnel stationed there, for losses of financing, business and reputation, and for loss of profit, except anticipated profit arising directly from the Work.

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This mutual waiver is applicable, without limitation, to all consequential damages due to either party's ~~termination in accordance with Article 14.~~ termination. Nothing contained in this Section 15.1.7 shall be deemed to preclude assessment of liquidated damages, when applicable, in accordance with the requirements of the Contract Documents.

§ 15.2 Initial Decision

§ 15.2.1 ~~Claims, excluding those where the condition giving rise to the Claim is first discovered after expiration of the period for correction of the Work set forth in Section 12.2.2 or arising under Sections 10.3, 10.4, and 11.5, shall~~ Claims of the Contractor shall, and Claims of the Owner may, be referred to the Initial Decision Maker for initial ~~decision.~~ interpretation. The Architect will serve as the Initial Decision ~~Maker, unless otherwise indicated in the Agreement.~~ Maker. Except for those Claims excluded by this Section 15.2.1, an initial ~~decision~~ interpretation shall be required as a condition precedent to ~~mediation of any Claim. If an initial decision~~ mediation, arbitration and/or litigation of any Claim brought by the Contractor against the Owner. If an initial interpretation has not been rendered within 30 days after ~~the~~ a Contractor-required or Owner-requested Claim has been referred to the Initial Decision Maker, the party asserting the Claim may demand mediation and binding dispute resolution without ~~a decision~~ an interpretation having been rendered. Unless the Initial Decision Maker and all affected parties agree, the Initial Decision Maker will not decide disputes between the Contractor and persons or entities other than the Owner.

§ 15.2.2 The Initial Decision Maker will review Claims and within ten days of the receipt of a Claim take one or more of the following actions: (1) request additional supporting data from the claimant or a response with supporting data from the other party, (2) reject the Claim in whole or in part, (3) approve the Claim, (4) suggest a compromise, or (5) advise the parties that the Initial Decision Maker is unable to resolve the Claim if the Initial Decision Maker lacks sufficient information to evaluate the merits of the Claim or if the Initial Decision Maker concludes that, in the Initial Decision Maker's sole discretion, it would be inappropriate for the Initial Decision Maker to ~~resolve the Claim.~~ interpret the Claim. Within ten (10) days of a written request, the Contractor shall make available to the Owner or its representative all of its books, records, or other documents in its possession or to which it has access relating to a Claim and shall require its Subcontractors, regardless of tier, and suppliers to do the same.

§ 15.2.3 In evaluating Claims, the Initial Decision Maker may, but shall not be obligated to, consult with or seek information from either party or from persons with special knowledge or expertise who may assist the Initial Decision Maker in rendering ~~a decision.~~ an interpretation. The Initial Decision Maker may request the Owner to authorize retention of such persons at the Owner's expense.

§ 15.2.4 If the Initial Decision Maker requests a party to provide a response to a Claim or to furnish additional supporting data, such party shall respond, within ten days after receipt of the request, and shall either (1) provide a response on the requested supporting data, (2) advise the Initial Decision Maker when the response or supporting data will be furnished, or (3) advise the Initial Decision Maker that no supporting data will be furnished. Upon receipt of the response or supporting data, if any, the Initial Decision Maker ~~will~~ will, based on its interpretation, either reject or approve the Claim in whole or in part.

§ 15.2.5 The Initial Decision Maker will render an initial ~~decision~~ interpretation approving or rejecting the Claim, or indicating that the Initial Decision Maker is unable to resolve the Claim. This initial ~~decision~~ interpretation shall (1) be in writing; (2) state the reasons therefor; and (3) notify the parties and the Architect, if the Architect is not serving as the Initial Decision Maker, of any recommended change in the Contract Sum or Contract Time or both. ~~The initial decision shall be final and binding on the parties but subject to mediation and, if the parties fail to resolve their dispute through mediation, to binding dispute resolution.~~ If the Claim is timely and properly asserted, the initial interpretation shall be subject to the parties' agreed-upon dispute resolution process.

§ 15.2.6 ~~Either party may file for mediation of an initial decision at any time, subject to the terms of Section 15.2.6.1.~~ **NOT USED.**

§ 15.2.6.1 ~~Either party may, within 30 days from the date of receipt of an initial decision, demand in writing that the other party file for mediation. If such a demand is made and the party receiving the demand fails to file for mediation within 30 days after receipt thereof, then both parties waive their rights to mediate or pursue binding dispute resolution proceedings with respect to the initial decision.~~

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§ 15.2.7 In the event of a Claim against the Contractor, the ~~Owner~~ Owner, Architect or Initial Decision Maker may, but is not obligated to, notify the surety, if any, of the nature and amount of the Claim. If the Claim relates to a possibility of a Contractor's default, the ~~Owner~~ Owner, Architect or Initial Decision Maker may, but is not obligated to, notify the surety and request the surety's assistance in resolving the controversy.

~~**§ 15.2.8** If a Claim relates to or is the subject of a mechanic's lien, the party asserting such Claim may proceed in accordance with applicable law to comply with the lien notice or filing deadlines.~~

§ 15.3 Mediation

§ 15.3.1 Except as stated in this Agreement or otherwise agreed in writing by the parties, Claims, disputes, or other matters in controversy arising out of or related to the Contract, except those waived as provided for in Sections ~~9.10.4, 9.10.5, and 15.1.7,~~ 9.10.4 and 9.10.5, shall be subject to mediation as a condition precedent to ~~binding dispute resolution.~~the parties' agreed-upon dispute resolution process.

§ 15.3.2 The parties shall endeavor to resolve their Claims by mediation which, unless the parties mutually agree otherwise, shall be administered by the American Arbitration Association in accordance with its Construction Industry Mediation Procedures in effect on the date of the Agreement. A request for mediation shall be made in writing, delivered to the other party to the Contract, and filed with the person or entity administering the mediation. The request may be made concurrently with the ~~filing of binding~~ commencement of the parties-agreed-upon dispute resolution proceedings but, in such event, mediation shall proceed in advance of ~~binding dispute resolution~~ such proceedings, which shall be stayed pending mediation for a period of 60 days from the date of filing, unless stayed for a longer period by agreement of the parties or court order. ~~If an arbitration is stayed pursuant to this Section 15.3.2, the parties may nonetheless proceed to the selection of the arbitrator(s) and agree upon a schedule for later proceedings.~~ All limitations periods shall be tolled during the mediation process.

§ 15.3.3 ~~Either party may, within 30 days from the date that mediation has been concluded without resolution of the dispute or 60 days after mediation has been demanded without resolution of the dispute, demand in writing that the other party file for binding dispute resolution. If such a demand is made and the party receiving the demand fails to file for binding dispute resolution within 60 days after receipt thereof, then both parties waive their rights to binding dispute resolution proceedings with respect to the initial decision.~~**NOT USED.**

§ 15.3.4 The parties shall share the mediator's fee and any filing fees equally. The mediation shall be held in the place where the Project is located, unless another location is mutually agreed upon. Agreements reached in mediation shall be enforceable as settlement agreements in any court having jurisdiction thereof.

~~**§ 15.4 Arbitration**~~

~~**§ 15.4.1** If the parties have selected arbitration as the method for binding dispute resolution in the Agreement, any Claim subject to, but not resolved by, mediation shall be subject to arbitration which, unless the parties mutually agree otherwise, shall be administered by the American Arbitration Association in accordance with its Construction Industry Arbitration Rules in effect on the date of the Agreement. The Arbitration shall be conducted in the place where the Project is located, unless another location is mutually agreed upon. A demand for arbitration shall be made in writing, delivered to the other party to the Contract, and filed with the person or entity administering the arbitration. The party filing a notice of demand for arbitration must assert in the demand all Claims then known to that party on which arbitration is permitted to be demanded.~~

~~**§ 15.4.1.1** A demand for arbitration shall be made no earlier than concurrently with the filing of a request for mediation, but in no event shall it be made after the date when the institution of legal or equitable proceedings based on the Claim would be barred by the applicable statute of limitations. For statute of limitations purposes, receipt of a written demand for arbitration by the person or entity administering the arbitration shall constitute the institution of legal or equitable proceedings based on the Claim.~~

~~**§ 15.4.2** The award rendered by the arbitrator or arbitrators shall be final, and judgment may be entered upon it in accordance with applicable law in any court having jurisdiction thereof.~~

~~**§ 15.4.3** The foregoing agreement to arbitrate and other agreements to arbitrate with an additional person or entity duly consented to by parties to the Agreement, shall be specifically enforceable under applicable law in any court having jurisdiction thereof.~~

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§ 15.4.4 Consolidation or Joinder

The Contractor further agrees to include similar dispute resolution provisions in all agreements with the Subcontractors, suppliers, and independent contractors and consultants retained for the Project and to require them to include a similar dispute resolution provision in all agreements with Subcontractors, all subconsultants, suppliers or fabricators so retained, thereby providing for a consistent method of dispute resolution between the parties to those agreements. Subject to the other limitations periods identified in these General Conditions which are understood to govern over this sentence, no demand for mediation or arbitration shall be made after the date when the applicable statutes of limitation would bar legal or equitable proceedings. During the pendency of any mediation or arbitration, all applicable limitations periods shall be tolled until the conclusion of that process.

The Owner reserves the right in its discretion to require consolidation or joinder of any mediation or other legal proceeding arising out of or relating to this Agreement or any of the agreements incorporated by reference with another mediation or other legal proceeding involving (i) a person or entity not a party to this Agreement or (ii) an independent contractor or consultant engaged by the Owner in connection with the Project, in any event the Owner believes such consolidation or joinder is necessary in order to resolve a dispute or avoid duplication of time, expense or effort. In the event the Owner is involved in a dispute which is not subject to mediation or arbitration involving a person or entity not a party to this Agreement, the mediation and arbitration provisions of this article shall be deemed to be void and nonexistent in the event Owner, in its discretion, determines the Contractor should become a party to that dispute by joinder or otherwise. Any mediation or arbitration hearing shall be held in the general location where the Project is located, unless another location is mutually agreed upon.

Modified: 09/26/22; 11:22 am~~§ 15.4.4.1 Subject to the rules of the American Arbitration Association or other applicable arbitration rules, either party may consolidate an arbitration conducted under this Agreement with any other arbitration to which it is a party provided that (1) the arbitration agreement governing the other arbitration permits consolidation, (2) the arbitrations to be consolidated substantially involve common questions of law or fact, and (3) the arbitrations employ materially similar procedural rules and methods for selecting arbitrator(s).~~

~~§ 15.4.4.2 Subject to the rules of the American Arbitration Association or other applicable arbitration rules, either party may include by joinder persons or entities substantially involved in a common question of law or fact whose presence is required if complete relief is to be accorded in arbitration, provided that the party sought to be joined consents in writing to such joinder. Consent to arbitration involving an additional person or entity shall not constitute consent to arbitration of any claim, dispute or other matter in question not described in the written consent.~~

~~§ 15.4.4.3 The Owner and Contractor grant to any person or entity made a party to an arbitration conducted under this Section 15.4, whether by joinder or consolidation, the same rights of joinder and consolidation as those of the Owner and Contractor under this Agreement.~~

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_____

(Signed)

_____

(Title)

_____

(Dated)

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CHRISTMAN
BUILDING SINCE 1894

Printed on Tue Nov 22, 2022 at 06:51 pm EST

Job #: 221125-010 Averill Elementary AC Project
3201 Averill, Dr.
Lansing, Michigan 48911

The Christman Company

Current Drawings

Drawing No.	Drawing Title	Revision	Drawing Date	Received Date	Set
General					
G-001	COVER SHEET	1	11/11/2022	11/15/2022	CD Set (11/15/22)
Architectural					
A-001	ARCHITECTURAL LEGENDS, SYMBOLS, AND ABBREVIATIONS	1	11/11/2022	11/15/2022	CD Set (11/15/22)
A-002	STRUCTURAL DETAILS	1	11/11/2022	11/15/2022	CD Set (11/15/22)
A-101A	FLOOR PLAN - AREA A	1	11/11/2022	11/15/2022	CD Set (11/15/22)
A-101B	FLOOR PLAN - AREA B	1	11/11/2022	11/15/2022	CD Set (11/15/22)
A-111A	REFLECTED CEILING PLAN - AREA A	1	11/11/2022	11/15/2022	CD Set (11/15/22)
A-111B	REFLECTED CEILING PLAN - AREA B	1	11/11/2022	11/15/2022	CD Set (11/15/22)
A-201	ELEVATIONS & DETAILS	1	11/11/2022	11/15/2022	CD Set (11/15/22)
AD101A	DEMOLITION PLAN - AREA A	1	11/11/2022	11/15/2022	CD Set (11/15/22)
AD101B	DEMOLITION PLAN - AREA B	1	11/11/2022	11/15/2022	CD Set (11/15/22)
Mechanical					
M-001	MECHANICAL LEGENDS	1	11/11/2022	11/15/2022	CD Set (11/15/22)
M-501	MECHANICAL DETAILS	1	11/11/2022	11/15/2022	CD Set (11/15/22)
M-601	MECHANICAL SCHEDULES	1	11/11/2022	11/15/2022	CD Set (11/15/22)
MD101A	DEMOLITION PLAN - FIRST LEVEL - AREA A	1	11/11/2022	11/15/2022	CD Set (11/15/22)
MD101B	DEMOLITION PLAN - FIRST LEVEL - AREA B	1	11/11/2022	11/15/2022	CD Set (11/15/22)
MH101A	HVAC PLAN - FIRST LEVEL - AREA A	1	11/11/2022	11/15/2022	CD Set (11/15/22)
MH101B	HVAC PLAN - FIRST LEVEL - AREA B	1	11/11/2022	11/15/2022	CD Set (11/15/22)
MP101A	PIPING PLAN - FIRST LEVEL - AREA A	1	11/11/2022	11/15/2022	CD Set (11/15/22)
MP101B	PIPING PLAN - FIRST LEVEL - AREA B	1	11/11/2022	11/15/2022	CD Set (11/15/22)
Electrical					
E-001	GENERAL NOTES AND LEGENDS	1	11/11/2022	11/15/2022	CD Set (11/15/22)
ED101A	DEMOLITION PLAN - AREA A	1	11/11/2022	11/15/2022	CD Set (11/15/22)
ED101B	DEMOLITION PLAN - AREA B	1	11/11/2022	11/15/2022	CD Set (11/15/22)
EP101A	ELECTRICAL PLAN - AREA A	1	11/11/2022	11/15/2022	CD Set (11/15/22)
EP101B	ELECTRICAL PLAN - AREA B	1	11/11/2022	11/15/2022	CD Set (11/15/22)

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Job #: 221125-070 Lyons Elementary AC Project
2901 Lyons Ave.
Lansing, Michigan 48910

The Christman Company

Current Drawings

Drawing No.	Drawing Title	Revision	Drawing Date	Received Date	Set
General					
G-001	COVER SHEET	1	11/11/2022	11/15/2022	CD Set (11/15/22)
Architectural					
A-001	ARCHITECTURAL LEGENDS, SYMBOLS, AND ABBREVIATIONS	1	11/11/2022	11/15/2022	CD Set (11/15/22)
A-002	STRUCTURAL DETAILS	1	11/11/2022	11/15/2022	CD Set (11/15/22)
A-101	FLOOR PLAN	1	11/11/2022	11/15/2022	CD Set (11/15/22)
A-102	ROOF PLAN	1	11/11/2022	11/15/2022	CD Set (11/15/22)
A-201	EXTERIOR ELEVATIONS	1	11/11/2022	11/15/2022	CD Set (11/15/22)
A-401	INTERIOR ELEVATIONS	1	11/11/2022	11/15/2022	CD Set (11/15/22)
AD101	DEMOLITION PLAN	1	11/11/2022	11/15/2022	CD Set (11/15/22)
Mechanical					
M-001	MECHANICAL LEGEND, SYMBOLS, AND ABBREVIATIONS	1	11/11/2022	11/15/2022	CD Set (11/15/22)
M-100	MECHANICAL PLAN - TUNNEL LEVEL	1	11/11/2022	11/15/2022	CD Set (11/15/22)
M-101	MECHANICAL PLAN - FIRST LEVEL	1	11/11/2022	11/15/2022	CD Set (11/15/22)
M-102	MECHANICAL PLAN - ROOF LEVEL	1	11/11/2022	11/15/2022	CD Set (11/15/22)
M-501	MECHANICAL DETAILS	1	11/11/2022	11/15/2022	CD Set (11/15/22)
M-601	MECHANICAL SCHEDULES	1	11/11/2022	11/15/2022	CD Set (11/15/22)
M-602	MECHANICAL SCHEDULES	0	11/11/2022	11/15/2022	CD Set (11/15/22)
M-701	TEMPERATURE CONTROLS LEGEND AND DIAGRAMS	1	11/11/2022	11/15/2022	CD Set (11/15/22)
MD100	MECHANICAL DEMOLITION PLAN - TUNNEL LEVEL	1	11/11/2022	11/15/2022	CD Set (11/15/22)
MD101	MECHANICAL DEMOLITION PLAN - FIRST LEVEL	1	11/11/2022	11/15/2022	CD Set (11/15/22)
Electrical					
E-001	ELECTRICAL SYMBOLS AND ABBREVIATIONS	1	11/11/2022	11/15/2022	CD Set (11/15/22)
E-002	ELECTRICAL SYMBOLS AND ABBREVIATIONS	1	11/11/2022	11/15/2022	CD Set (11/15/22)
E-211	FIRST LEVEL POWER & AUXILIARY PLAN	1	11/11/2022	11/15/2022	CD Set (11/15/22)
E-212	ROOF LEVEL POWER & AUXILIARY PLAN	1	11/11/2022	11/15/2022	CD Set (11/15/22)
E-401	ELECTRICAL SINGLE LINE DIAGRAM	1	11/11/2022	11/15/2022	CD Set (11/15/22)
E-501	ELECTRICAL DETAILS	1	11/11/2022	11/15/2022	CD Set (11/15/22)
ED-111	FIRST LEVEL ELECTRICAL DEMOLITION PLAN	1	11/11/2022	11/15/2022	CD Set (11/15/22)

Section 00210 - Special Provisions

1. General - All Bidders are responsible to review all work categories descriptions, and report any conflicts or ambiguities which may affect the execution of their Work Categories. All Bidders are responsible to review all Bidding Documents and become familiar with them to coordinate their work accordingly. Work Category descriptions should in no way be construed as being all-inclusive. Should a conflict exist between the Work Category description and other Bidding Documents, the Work Category description shall prevail and take precedence. Bidders are required to bid the entire Work Category and may bid more than one Work Category.
2. Electronic Documentation – In an effort to promote sustainability, information shall be conveyed electronically to the greatest extent possible.
3. Pre-approved contractors – The invitation procedure requires that each primary bidder be pre-qualified by the Construction Manager. If you are unsure if you are pre-qualified please contact Andrew Dobbs immediately at 517-482-1488. Subcontractors and vendors responding to the primary bidders do not need to be pre-qualified. To become pre-qualified, please visit the following link - (http://www.christmanco.com/documents_forms.asp) and fill out the "Trade Contractor Information Request" form.
4. Labor Requirements – None
5. Construction Waste Management And Disposal – Review Spec Section 017419 Construction Waste Management And Disposal.
6. General Commissioning Requirements – Review Spec Section 019113 General Commissioning Requirements.
7. Indoor Air Quality Management Plan – During Construction. Comply with site specific IAQ Management Plan for this project.
8. Parking – Parking is available within school's existing parking lots.
9. Project Scheduling - A preliminary project schedule has been included within the Bidding Documents for your review and use. As input from the Trade Contractors is provided and as progress begins, this schedule will be periodically updated and re-issued. Each Trade Contractor is required to become familiar with the preliminary schedule and sequence their work accordingly. Activity durations shall be maintained regardless of actual start dates.
10. Post Bid interviews – We will be holding post bid interviews for the low qualified bidders immediately after bids are received. It is essential to the interview process that the primary and secondary Trade Contractors are included in the meeting, as well as the intended project foreman and project manager. The purpose of the interview will be to discuss the bids but will also focus on schedule, submittals, safety, site utilization and unique project requirements.
11. Shop Drawings & Submittals –The Trade Contractor shall review, approve in writing, and submit through the Construction Manager all submittals within two weeks after contract award at the latest, as to cause no delay in the work or in the work of any separate Trade Contractor. Shop drawings, product data and samples shall be properly identified as specified or as the Construction Manager may require. At the time of submission, each Trade Contractor shall inform the Construction Manager in writing of any deviation in the shop drawings, product data or samples from the requirements of the Bidding Documents.

For Re-Submittals – Each Trade Contractor shall make any corrections required by the Construction Manager or Architect and shall resubmit the shop drawings, product data or new samples until approved. Each Trade Contractor shall direct specific attention, in writing or on resubmitted shop drawings, product data or samples, to revisions other than those requested by the Construction Manager or Architect on previous submittals. Refer to Section 01300 Submittals for definitions of Action Markings.)

FINAL UNRESTRICTED RELEASE: Marking: _____ (i.e. "No Exceptions Taken" or "Reviewed")

MAKE CORRECTIONS NOTED: Marking: _____ (i.e. "Approved as Noted")

REVISE AND RESUBMIT: Marking: _____ (i.e. "Revise and Resubmit")

REJECTED: Marking: _____ (i.e. "Rejected")

12. Procore –The Christman Company has set up a Procore project for the construction documents for the project. Procore will be used for (not limited to) the following:
    a. Submittals
    b. RFIs
    c. Updated drawings
    d. Updated schedule
    e. Meeting minutes
    f. Project directory
    g. Testing reports
    h. Notice of commencement
    i. Punchlist
    j. Safety Information

13. Submittal Uploads –All submittals must be submitted to The Christman Company via Procore and must be the original PDF document. Hard copies or re-scanned documents will not be accepted. The only exception is actual samples (paint draw downs, masonry, etc.); however, all brochures and product data related to these samples must be submitted electronically.

    Schedule of Values (SOV) – Per Section 01370 Schedule of Values, submit for approval through the Trade Contractor Portal. Once approved, adhere to the Application for Payment process. The SOV must be divided up by: type of work, general conditions, supervision, insurance, material and labor.

14. Application for payment – Create and Submit the Pay Application through the Trade Contractor Portal. Payment period: Payment applications are due the 25th of each month. Each request for payment shall be provided with a fully executed sworn statement along with its relative unconditional waivers. All subcontractors and suppliers are to be listed on the sworn statement.

15. Change Management – Refer to Sections 01150 and 01019 for definitions, but the following change management documents will be utilized on this project: Bulletins

16. Existing Services – The existing utilities and fixtures (power, plumbing, fire alarm system and fire suppression) will remain in operation during construction. Care must be taken when working around the

site and in the building. The Owner will pay for all power consumed for the temporary electrical service, all natural gas consumed for temporary heat, and all water consumed for temporary potable water.

Under conditions where tie-ins to existing services/utilities are required, each Trade Contractor will be required to notify Construction Manager five (5) working days in advance. Pre-Task planning and shut-down notifications will be required to assure minimum interruptions to Owner operations, including performing required tie-ins after normal working hours. Trade Contractors are responsible to cover premium time costs to complete required tie-ins.)

17. Existing Facilities – The toilet facilities in the existing buildings shall not be utilized. Portable chemical toilets will be provided.

18. Material Deliveries and Staging – Due to the limited lay-down area available, all material deliveries must be coordinated with the Construction Manager a minimum of 24-hours in advance of said delivery. At no time, will delivery trucks be allowed to stage or park on existing roads and parking lots. Queuing for trucks will be available on-site at designated locations as coordinated with the Construction Manager. If deliveries require traffic control, the Trade Contractor is required to provide flagmen accordingly. All Trade Contractors are responsible for directing responsible trucks into project site, unloading of materials, handling, protection and storage of all received equipment. The Owner and Construction Manager will not accept deliveries.

19. Communication and Phones –All Trade Contractor field supervision shall have cellular phones available for communication with The Christman Company's field personnel. All project managers shall have email access for communications with The Christman Company's office personnel. Cell phone use by trade personnel (non-supervisory) will not be permitted, except during breaks or lunch.

20. Independent Testing, Inspections and Commissioning – The Owner has arranged independent testing for certain portions of the project. All Trade Contractors are to cooperate and provide access and assistance for the independent testing and inspections to be performed. These services include at a minimum: soil/material testing and commissioning.

21. Noise, Odors & Vibration – Due to close proximity of adjacent existing facilities, vibration must be closely monitored as to not cause any damage to the existing building and facilities. Odor causing chemicals, adhesives, paints, cleaning supplies must have MSDS sheets submitted and approved by the Construction Manager prior to use. All equipment shall be self powered and all diesel powered equipment shall be operated with "Bio-diesel" fuels and/or emission "scrubbers" to reduce exhaust fumes.

22. Jobsite Safety Orientation – All Trade Contractors of any tier and visitors entering this jobsite will be required to check-in with the Construction Manager upon arrival at the project site. Check-in procedures will include the review and acknowledgement of the Construction Managers Project Specific Safety Orientation and Policies. All construction personnel will be required to wear The Christman Company issued safety sticker when working on or visiting this jobsite).

    a. Safety (see contract form section for project safety program) - It is a fundamental value of the Construction Manager that safety is always a primary consideration. There is no phase of the project that has greater importance than accident prevention and the preservation of human resources. The Construction Manager's safety program is stringent and rigorous. The following represents a few important pre-construction requirements that apply to this project. Before any awarded Trade Contractor starts work on-site, the following requirements shall be satisfied:

        i. Provide a copy of Trade Contractor's site specific safety program.

ii. Attend Construction Manager's project specific safety orientation program, which includes review of our safety video, review of project specific written safety program, review of Project Specific Infection Control Policy, sign-in and badging requirements.

iii. No tobacco products, including but not limited to cigarettes, cigars, chewing tobacco, etc. are permitted on Lansing School District premises.

iv. Provide a copy of Material Safety Data Sheets (MSDS) for all proposed materials.

v. Hardhats and safety glasses are to be worn at all times. Additional personal protection equipment will be worn appropriately based on the work performed.

vi. Designate a Safety Representative(s) who will be working on-site – Provide telephone numbers and emergency telephone numbers.

vii. Hoisting over occupied areas will not be permitted unless areas are vacated or a controlled access program initiated.

viii. Hot work permits shall be obtained as required, including fire watch requirements.

ix. Shut down notifications shall be obtained as required with a minimum of five (5) working days advance notice.

x. An understanding of our safety program and specifically our policy that in the event of an injury or near miss, all parties involved will be required to take a drug screening test immediately. Failure to perform the required test will result in removal from the site.

xi. Fall protection shall be worn and used, 100% of the time, by all persons when there is exposure to a fall greater than six (6) feet unless other provisions such as guardrails, safety nets, or fall restraints have been provided. This includes, but is not limited to, steel erection (including connecting, bolting-up, decking, welding or any other steel erection activity), pre-cast erection, roofing activities and masonry work including overhand laying operations.

xii. Hot Work Permits - Hot work permits will be required during all cutting, grinding, welding and torch cutting activities, including fire watch requirements. These permits are to be filled out in the jobsite trailer with a copy of it to be placed at the place of hot work.

23. Progress Cleanup – A composite clean-up crew will be assembled each Friday immediately after lunch. Each Trade Contractor shall provide labor and supplies as directed by the Construction Manager to support this effort. This does not relieve any Trade Contractor of their responsibility to cleanup all debris resulting from their own operations on a daily basis and discard waste into jobsite dumpsters provided by the Construction Manager (as identified in section 01524), Each Trade Contractor shall clean all surfaces and leave the work area "broom clean" or its equivalent, unless otherwise specified.

    If contractors do not maintain their work areas or provide the proper resources for our daily clean up, The Christman Company will provide one warning to the contractor. If the problem continues after the warning, The Christman Company will provide labor for the relative clean-up at the cost of the contractor.

24. Drug Testing – Drug testing is mandatory in the event of an incident or accident that questions the sobriety of the individual.

25. As-Builts – As-Builts must be accurately updated throughout the project. At the end of the project, the trade contractor must update the As-Builts and forward the following to The Christman Company: CAD drawing file, PDF file and two full size hard copies.

26. Warranties –The contractor shall guarantee all materials and work for a period of one year from Substantial Completion. Before final payment, Contactor must provide a letter of guarantee confirming the effective date and duration of the guarantee.

27. Waste Management/Indoor Air Quality Plan – The Construction Manager's Waste Management Plan and Indoor Air Quality plan will be strictly adhered to for this project. Please pay special attention to these specifications (01410 and 01524). The trade contractors are responsible to provide the necessary resources to follow these guidelines.

28. Phasing – None, all completed in summer of 2023 during school's summer break.

29. RFI's – All pre-bid RFIs should be emailed to projects@lansingschools.net. RFIs during construction will be done via Procore.

30. Work Hours - Common jobsite working hours shall be 7:00 am to 3:30 pm, Monday through Friday. Any overtime requires advance approval by Construction Manager.

31. Hazardous Materials – Report to the Construction Manager if any suspicious hazardous materials are found.

32. Alternates –

    a. Alternate 1 at Lyons - Work Associated with Storage Room 114S

33. Sealant Schedule - Sealants are to be installed as listed in the schedule below. If sealants are required by the specification for a specific system that is are not listed, then the Trade Contractor installing the product shall be responsible for the associated caulking. All caulking integral to one's system is the responsibility of that contractor.

Sealant Schedule		
Item to be sealed	Responsible WC	Comments
Concrete	20	
Glazing Systems	18	
Masonry Systems	20	
Countertops	20	
Louvers	27	

End of Special Provisions Section 00210

01010 SUMMARY OF WORK

01011 RELATED DOCUMENTS

1.1 Drawings and general provisions of the Contract including General and Supplementary Conditions and Division 1 Specification Sections, apply to work specified in this section.

1.2 Information given in the Division 1 General Requirements shall supplement information given in the General and Supplementary Conditions. The most stringent provision in the General Conditions, General Requirements, Contract Drawings and Specifications shall govern the execution of any work or requirement.

01012 CONSTRUCTION MANAGER

1.1 The Christman Company is the Construction Manager. Wherever the term General Contractor or Contractor (in the context of the General Contractor) is used, it shall be given the same meaning as Construction Manager.

1.2 The Trade Contractor and his sub-Trade Contractors shall agree to and accept the same responsibility and follow the same terms of the Conditions of the Contract as the Construction Manager for the work for which he is under contract.

01013 PROJECT

1.1 The Work as defined in the General Conditions and described in the Contract Document.

01014 RELATED WORK NOT-IN-CONTRACT (NIC)

1.1 Reference Section 00210 for any work that will be performed by the Owner or accomplished under separate contract.

01015 REPLACEMENT MATERIAL (For Owner's future use)

1.1 If any specific amounts are called for in the individual Sections, provide the specified amounts. If none are specified and a surplus is left, request instructions from the Construction Manager before discarding the surplus.

01016 LABOR, MATERIALS, TAXES & WORKMANSHIP

1. LABOR AND MATERIALS

1.1 Unless otherwise specified in these Contract Documents, all materials and workmanship shall be new and of the best grade of their respective kind for the purpose.

1.2 Unless otherwise specifically provided in the Contract Documents, the Trade Contractor shall provide and pay for all labor, materials, equipment, tools, construction equipment and machinery, transportation, and other facilities and services necessary for the proper execution and completion of the Work.

1.3 The Trade Contractor shall at all times enforce strict discipline and good order among his employees and shall not employ on the Work any unfit person or anyone not skilled in the task assigned to him.

2. TAXES

2.1 Unless tax exempt status is specifically noted, it is understood that the bid prices stated shall include all applicable Federal, State or other Governmental division taxes and assessments. Also, all contributions for unemployment compensation, health and welfare, old age benefits or other purposes now or hereafter effective during the term of the contract, and the Owner and Construction Manager shall not be liable for any additional charges therefore.

01017 CRITICAL PHASING & STAGES OF CONSTRUCTION

1. INTRODUCTION

1.1 Critical phasing and critical stages of construction have been established herein for the project. It is extremely important that the "Critical Phasing & Stages of Construction" requirements be understood and complied with.

1.2 The Construction Manager shall coordinate detailed critical phasing and sequencing and scheduling with the Owner's representative.

1.3 The Construction Manager shall provide overall scheduling and coordination for the entire project. All Trade Contractors shall acknowledge the Construction Manager's right to establish and set up, or subsequently modify, the sequencing and scheduling of all Work on this project for the earliest completion and/or benefit to the Owner.

1.4 All Trade Contractors shall expedite the ordering and delivering of materials and equipment, etc. to meet these critical phasing and staging requirements and to make every effort possible to minimize disruption of normal building usage.

2. BID SCHEDULES

2.1 The preliminary construction schedule narrative included in the Contract Documents represents the general order and time frames for work to be followed by the Construction Manager in coordinating the project. Trade Contractors are to assume that their work will be coordinated in a manner consistent with industry practice, and the efficient coordination of all other trades. Trade Contractors recognize and accept their work may be sequenced and paced by other trades.

2.2 Please note that although the schedule defines the planned order of construction, Bidders should not assume that any assurance is given or implied as to the calendar dates associated with completion of the work of a particular contract.

2.3 All Trade Contractors and Trade Subcontractors recognize and shall accept modifications to the schedule which are reasonable, in the opinion of the Construction Manager, for the general interest of the project as a result of allowable time extensions (formally or informally approved) in any contract, and such modifications are inherent to the construction process and shall not qualify as a basis for extra compensation from the Construction Manager or Owner.

2.4 The Trade Contractor, in submitting a proposal for the work of a particular work category, agrees to commit the necessary resources to complete the work activities of that work category, within a time span not greater than the planned duration. Work included within a work category, but not specifically defined by a particular work activity, is to be accomplished in a reasonable manner

in conjunction with other work of the work category, and in such a way as to avoid complication of or to delay the work of other Trade Contractors.

3. PROJECT SEQUENCING

3.1 GENERAL SEQUENCING

3.1.1 The overall project sequencing is indicated within the Preliminary Construction Schedule. Refer to Section 00200 and Section 01310.

3.2 RESTRICTIVE SEQUENCING & SCHEDULING

3.2.1 More restrictive sequencing to coordinate the Owner's on-going operations and/or for the coordination of the various trades shall be identified in Section 00210 SPECIAL PROVISIONS or as otherwise directed by the Construction Manager; All Trade Contractors agree to cooperate and alter their operations to maintain these more specified restrictions and sequences of the work.

3.3 SPECIFIC PROJECT REQUIREMENTS

3.3.1. Refer to the work category description and Section 00210 for specific information on scheduling requirements.

4. MUTUAL COOPERATION

4.1. Mutual cooperation between the Owner, the Architect, the Construction Manager, and the Trade Contractors to coordinate these construction and building operation requirements is anticipated and expected.

01018 USE OF SITE

1.1 Trade Contractor shall limit his use of the premises for his work and for storage to allow for (I) work by other Trade Contractors; (ii) Owner occupancy; and (iii) public use.

1.2 Limitations on site usage as well as specified requirements that impact site utilization are indicated on the drawings and by other contract documents. In addition to these limitations and requirements, the Construction Manager will administer allocation of available space equitably among entities needing both access and space so as to produce the best overall efficiency in performance as the total work of the project. Schedule deliveries so as to minimize space and time requirements for storage of materials and equipment on site.

1.3 ACCESS TO SITE

Use of Site: Limit use of Project site to **work in areas** indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1.4 Trade Contractor shall assume full responsibility for the protection and safekeeping of products under his contract, stored on the site.

1.5 Move any stored products, under Trade Contractor's control, which interfere with operations of the Owner or separate Contractor.

1.6 Obtain and pay for the use of additional storage or work areas needed for operations.

1.7 Nonsmoking Building: Smoking is not permitted on LSD property.

01019 OWNER'S RIGHT TO OCCUPY

1.1 The Owner, at his election, may from time to time occupy any parts of the project as the work in connection therewith is completed to such a degree as will, in the opinion of the Owner, permit of their use for the purposes for which they are intended. The Owner will, prior to any such partial occupancy, give notice to the Construction Manager thereof and such occupancy shall be based upon the following:

a. Such occupancy shall not constitute an acceptance of work not performed in accordance with the Contract Documents or relieve Trade Contractors of liability to perform any work required by their Contract but not completed at the time of occupancy.

b. Trade Contractors shall be relieved of all maintenance costs on the units or parts occupied under this agreement.

c. Owner shall assume the risk of loss with respect to any unit or part occupied under the terms of this agreement.

d. The Trade Contractor shall not be required to furnish heat, light and water or other such services used in the units or parts occupied, without proper re-numeration therefore.

END OF SECTION

01019 CONTRACT CONSIDERATIONS

SECTION INCLUDES:

1.1 Inspection and Testing Allowance

1.2 Schedule of Values

1.3 Application for Payment

1.4 Change Procedures

1.1 INSPECTION & TESTING ALLOWANCES

If inspection and testing allowances have been assigned to the Trade Contractors, the following shall apply:

1.1.1 Costs included in allowances

a. Cost of engaging an inspection or testing firm, execution of inspection or tests, reporting results.

1.1.2 Costs not included in the allowance:

a. Incidental labor and facilities required to assist inspection or testing firm.

b. Costs of testing laboratory services required by Contractor separate from Contract Document requirements.

c. Costs of retesting upon failure of previous tests as determined by Architect-Engineer.

1.1.3 Payment Procedures:

a. Submit one copy of the inspection or testing firm's invoice with next application for payment.

b. Pay invoice on approval by Architect-Engineer.

1.1.4 Funds will be drawn from inspection and testing allowances only by Change Order.

1.2 SCHEDULE OF VALUES

1.2.1 Submit schedule through Contractor's Trade Contractor Portal. Application for Payments cannot be processed until Schedule of Values is approved. Without prior approval of the Construction Manager, **no single line item can exceed $150,000. Unless indicated otherwise, allowances and change orders must be listed as separate line items.**

The schedule of values must be itemized as follows:

1.2.2 Format: Unless instructed otherwise, utilize the Table of Contents of this Project Manual. Identify each line item with number and title of the major specification Section. Identify bonds, insurance, and permits separately.

1.2.3 Allowances should be added as individual line items for each section in the Schedule of Values.

1.2.4 Include within each line item, a directly proportional amount of Contractor's overhead and profit.

1.2.5 Approved Change Orders will automatically be added as a line item in the Schedule of Values through the Trade Contractor Portal.

1.3 APPLICATIONS FOR PAYMENT

1.3.1 Pay Applications are to be created and submitted through the Trade Contractor Portal which conforms to the AIA G702 Form. The Trade Contractor Portal is the exclusive method of submitting a payment application.

1.3.2 Payment Period: First of month to first of month unless agreed to otherwise.

1.3.3 Waiver of liens and Sworn Statements shall accompany all Payment Requests unless agreed to otherwise. Also to be produced and submitted through the Trade Contractor Portal.

1.4 CHANGE PROCEDURES

1.4.1 The Architect-Engineer will advise of minor changes in the Work not involving an adjustment to Contract Sum/Price or Contract Time as authorized by AIA A201, 1987 Edition, Paragraph 7.4.

1.4.2 The Architect-Engineer may issue a change management document which includes a detailed description of a proposed change with supplementary or revised Drawings and Specifications, a change in Contract Time for executing the change with a stipulation of any overtime work required and the period of time during which the requested price will be considered valid. Contractor will prepare and submit an estimate within five (5) calendar days.

1.4.3 The Contractor may propose a change by submitting request for change to the Architect-Engineer, describing the proposed change and its full effect on the Work. Include a statement describing the reason for the change, and the effect on the Contract Sum/Price and Contract Time with full documentation and a statement describing the effect on Work by separate or other contractors. Document any requested substitutions in accordance with Sections 01600 and 01600A.

1.4.4 Stipulated Sum/Price Change Order: Based on change management document and Contractor's fixed price quotation; or, Contractor's request for a Change Order as approved by Architect-Engineer.

1.4.5 Unit Price Change Order: For pre-determined unit prices and quantities, the Change Order will be executed on a fixed unit price basis. For unit costs or quantities of units of work, which are not pre-determined, execute Work under a change management document. Changes in Contract sum/Price or Contract Time will be computed as specified for Time and Material Change Order.

1.4.6 Change Management Document: Architect-Engineer may issue a change authorization signed by the Owner, instructing the Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order. Document will describe changes in the Work, and designate method of determining any change in Contract Sum/Price or Contract Time. Promptly execute the change.

1.4.7 Time and Material Change Order: Submit itemized account and supporting data after completion of change, within time limits indicated in the Conditions of the Contract. Architect-Engineer will determine the change allowable in Contract Sum/Price and Contract Time as provided in the Contract Documents.

a. Maintain detailed records of work done on Time and Material basis. Provide full information required for evaluation of proposed changes, and to substantiate costs for changes in the Work.

b. Execution of Change Orders: Architect-Engineer will issue Change Orders for signatures of parties as provided in the Conditions of the Contract.

c. Overhead and Profit: Overhead and Profit shall include the following:

d. Supervision, Superintendents, Commercial General Liability and Umbrella Insurances, Wage of Time Keepers, Watchmen and Clerks, Small tools with material value of less than $1,500.00, Incidentals, General Office Expense, and all other expenses not included in Labor Rates. The percentage fee for Overhead and Profit on the Contractor's own work shall be 15% of net cost. The percentage fee for Overhead and Profit on Subcontractor's work shall be 5%.

END OF SECTION

01020 ALLOWANCES

1. GENERAL

1.1 Allowances will be established as directed in the Work Category Descriptions and are required to be included within the Trade Contractor's base bid. The amount included is an actual cost and does not include overhead and profit. Overhead and profit shall be included in the Trade Contractor's base bid, not in the allowance. Charges against the allowances will be at the Trade Contractor's net rate without overhead and profit as it is already included in the Contractor's base bid. These allowances are set up to be used only when authorized by the Construction Manager. Labor charged against the allowances will be in accordance with mutually accepted labor rates listed in each Trade Contractor's respective contract. Work expended by use of the allowances may be billed for each month in the Trade Contractor's monthly billing provided proper documentation and allowance authorizations are provided. In the event a balance remains within a specific allowance at the end of the project, a change order will be issued deducting the balance remaining in the allowance from the Trade Contractor's contract. All savings as a result of the Trade Contractor's non-use of these allowances will be the Owner’s.

END OF SECTION

01030 SPECIAL PROJECT PROCEDURES

01031 ALTERATIONS

1.1 ASBESTOS ADVISORY

1.1.1 All asbestos contaminated materials shall be removed by the Owner.

1.2 NON-ABATEMENT TRADE CONTRACTOR RESPONSIBILITIES

1.2.1 Some areas of this project may contain asbestos in some locations. The Owner will attempt to remove or encapsulate all known asbestos prior to the start of renovations. This section contains the asbestos related requirements of all Trade Contractors working on this project.

1.3 GENERAL REQUIREMENTS

1.3.1 All Federal, State and local laws, rules, regulations and ordinances for asbestos related work shall be adhered to, including but not limited to, OSHA, MIOSHA, EPA and DEQ.

1.3.2 All Non-Abatement Trade Contractors working around asbestos containing materials are to have a minimum of 2-hours of awareness training on the health and safety aspects of asbestos.

1.3.3 All Non-Abatement Trade Contractors involved with the disturbance of Category I non-friable asbestos (roof felts, floor tile, transit chimney, etc.) are required to have all workers receive a minimum of 8-hours "hands-on" OSHA approved training prior to beginning work.

1.3.4 In addition a Non-Abatement Trade Contractor involved with the removal of Category I non-friable asbestos will have at least one on-site worker, employed by the Non-Abatement Trade Contractor, who has successfully completed an asbestos "Supervisor" course and received accreditation. The course shall meet the criteria of EPA's Model Accreditation Plan (40CFR Part 763) for Supervisor or its equivalent.

1.3.5 Documentation of said training must be posted at the job site during the removal of asbestos containing material(s), disposal, and/or handling.

1.3.6 Monitoring will be conducted pursuant to OSHA regulation 29 CFR 1926.1101.

1.3.7 **THE NON-ABATEMENT TRADE CONTRACTOR IS TO STOP WORK AND NOTIFY THE CONSTRUCTION MANAGER ANY TIME SUSPECTED ASBESTOS CONTAINING MATERIALS ARE ENCOUNTERED BY ANY OF HIS/HER WORKERS.**

1.3.8 All Non-Abatement Trade Contractors that will be removing Category I non-friable asbestos containing materials are to contact the Owner who will arrange and pay for the Environmental Consultant to provide air monitoring services.

1.4 EXCLUSIONARY STATEMENT FOR BUILDING CONSTRUCTION/RENOVATION MATERIALS

1.4.1 All building materials/products used for renovations or replacement purposes are to be asbestos and lead-free. Asbestos and lead-free is to be defined as materials that contain

0% asbestos or lead. All Contractors are to be prepared to submit data, for a building material/product that he/she is proposing or required to use, to verify the absence of asbestos and lead.

1.4.2 The Non-Abatement Trade Contractors are to complete and sign the form titled "Exclusionary Statement for Building Construction/Renovation Materials".

1.5 NOTIFICATION

1.5.1 All Non-Abatement Trade Contractors that are required to remove Category I non-friable asbestos are to fill out and submit to the Michigan Department of Natural Resources, the "**NOTIFICATION OF INTENT TO RENOVATE/DEMOLISH**", in accordance with the Asbestos National Emission Standards for Hazardous Air Pollutants (NESHAP) and the Department of Labor and Economic Growth (DLEG).

END OF SECTION

01040 COORDINATION

01041 GENERAL

1.1 The Construction Manager is ultimately responsible for coordination to complete all work shown on the drawings and specified herein independent of the location of the work on drawings and within the specifications. The arrangement of work within the specifications into Divisions and Sections shall be considered as given for convenience of reference only and shall not be held to conform to jurisdictional rules which may prevail in any particular trade. It shall be the responsibility of the Construction Manager to so arrange or group items of work under a particular trade to conform with the prevailing customs of that trade and best interest of the Owner.

01042 GENERAL INSTALLATION PROVISIONS

1.1 PRE-INSTALLATION CONFERENCES: The Construction Manager shall hold pre-installation meeting at the project site well before installation of each unit of work, which requires coordination with other work. Installer and representatives of the manufacturers and fabricators who are involved in or affected by that unit of work, and with its coordination or interpretation with other work that has preceded or will follow shall attend this meeting. The Construction Manager will advise the Architect/Engineer of scheduled meeting dates.

a. The Construction Manager shall record significant discussions of each conference, and record agreements and disagreements, along with the final plan of action. The Construction Manager shall then distribute the record of meeting promptly to everyone concerned, including the Owner and Architect/Engineer.

b. Do not proceed with the work if the pre-installation conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the work and reconvene pre-installation conference at the earliest possible date.

1.2 Installer's Inspection of Conditions: Require the installer of each major unit of work to inspect the substrate to receive work and conditions under which the work is to be performed. The installer shall report all unsatisfactory conditions in writing to the Construction Manager. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.

1.3 Coordinate enclosure of the work with required inspections and tests so as to minimize the necessity of uncovering work for that purpose.

1.4 Mounting Heights: Where mounting heights are not indicated. Refer to the Construction Manager for decision. Products installed at a location not indicated or approved by the Architect or Construction Manager shall be relocated at the Trade Contractor's expense.

01043 COORDINATION OF PERMANENT UTILITY CONNECTIONS

1.1 New utility connections shall be coordinated with local utilities and the Project Superintendent.

01044 MECHANICAL & ELECTRICAL COORDINATION

1.1 All Trade Contractors shall make arrangements with the Construction Manager before connecting to existing facilities. If interruption of service is required, it shall be done at the convenience of the Owner as scheduled by the Construction Manager / General Contractor.

END OF SECTION

01045 CUTTING AND PATCHING

1. GENERAL

1.1 RELATED DOCUMENTS

Drawing and general provisions of contract, including General and Supplementary Conditions and other Division 1 Specification sections apply to work of this Section.

1.2 DESCRIPTION OF REQUIREMENTS

1.2.1 Definition: "Cutting and patching" includes cutting into existing construction to provide for the installation or performance of other work and subsequent fitting and patching required to restore surfaces to their original condition.

a. "Cutting and patching" is performed for coordination of the work, to uncover work for access or inspection, to obtain samples for testing, to permit alterations to be performed or for other similar purposes.

1.3 RELATED WORK SPECIFIED ELSEWHERE

1.3.1 Refer to mechanical and electrical specifications sections for additional requirements and limitations on cutting and patching of mechanical and electrical work.

1.4 QUALITY ASSURANCE

1.4.1 Requirements for Structural Work: Do not cut and patch structural work in a manner that would result in a reduction of load-carrying capacity or of load-deflection ratio.

a. Before cutting and patching the following categories of work, obtain the Construction Manager's approval to proceed:

- Structural Steel - Miscellaneous structural metals, including lintels, equipment supports, stair systems and similar categories of work.
- Structural Concrete - Foundation construction, Retaining walls, Structural decking, Exterior wall construction, Piping, ductwork, vessels and equipment. Reinforcing steel shall not be heated to bend or reshape a bar.

b. Visual Requirements: Do not cut and patch work exposed on the building's exterior or in it's occupied spaces, in a manner that would, in the Architect/Engineer's opinion, result in lessening the building's aesthetic qualities. Do not cut and patch work in a manner that would result in substantial visual evidence of cut and patch work. Remove and replace work judged by the Architect/ Engineer to be cut and patched in a visually unsatisfactory manner.

2. PRODUCTS

2.1 MATERIALS

2.1.1 General: Use materials for cutting and patching that are identical to existing materials. If identical materials are not available, or cannot be used, use materials that match existing adjacent surfaces to the fullest extent possible with regard to visual effect. Use materials for cutting and patching that will result in equal-or-better performance characteristics.

3. EXECUTION

3.1 INSPECTION

3.1.1 Inspect existing conditions of the project, including elements subject to damage or to movement during cutting and patching.

3.1.2 After uncovering work, inspect the conditions affecting the installation of products or performance of the work.

3.1.3 Report unsatisfactory or questionable conditions to the Construction Manager in writing; do not proceed with the work until the Construction Manager has provided further instructions.

3.2 PREPARATION

3.2.1 Provide adequate temporary support as necessary to assure the structural value or integrity of the affected portion of the work.

3.2.2 Provide devices and methods to protect other portions of the project from damage.

3.2.3 Provide protection from the elements for that portion of the project, which may be exposed by cutting and patching work, and maintain excavations free from water.

3.3 PERFORMANCE

3.3.1 Execute cutting and demolition by methods which will prevent damage to other work, and will provide proper surfaces to receive installation or repairs. Cutting and patching shall be performed by individuals certified, licensed, or otherwise qualified as experienced and with sufficient training to perform the required task.

3.3.2 Execute excavating and backfilling by methods which will prevent settlement or damage to other work.

3.3.3 Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerances and finishes.

3.3.4 Restore work which has been cut or removed; install new products to provide complete work in accord with requirements of Contract Documents.

3.3.5 Fit work airtight to pipes, sleeves, ducts, conduit and other penetrations through surfaces.

3.3.6 Refinish entire surfaces as necessary to provide an even finish to match adjacent finishes.

3.3.7 For continuous surfaces refinish to nearest intersection. For an assembly, refinish the entire unit.

3.4 CLEANING

3.4.1 Thoroughly clean areas and spaces where work is performed or used as access to work. Remove completely paint, mortar, oils, putty and items of similar nature. Thoroughly clean piping, conduit and similar features before painting or other finishing is applied. Restore damaged pipe covering to its original condition.

4. CUTTING & PATCHING FOR MECHANICAL WORK

4.1 The Mechanical Contractor shall be responsible for all cutting, core drilling, and patching for their work. Cutting and patching shall be performed by individuals certified, licensed, or otherwise qualified as experienced and with sufficient training to perform the required task.

4.2 The Mechanical Contractor shall be responsible for the accurate location of all openings necessary for the installation of the mechanical work. Any additional openings required to move his work due to an error in the initial layout shall be made at the expense of the Mechanical Contractor.

5. CUTTING & PATCHING FOR ELECTRICAL WORK

5.1 The Electrical Contractor shall be responsible for all cutting, core drilling, and patching for their work. Cutting and patching shall be performed by individuals certified, licensed, or otherwise qualified as experienced and with sufficient training to perform the required task.

5.2 The Electrical Contractor shall be responsible for the accurate location of all openings necessary for the installation of the electrical work. Any additional openings required to move his work due to an error in the initial layout shall be made at the expense of the Electrical Contractor.

END OF SECTION

01049 MECHANICAL & ELECTRICAL COORDINATION

SECTION INCLUDES:

1.1 Mechanical and Electrical Coordinator

1.2 Submittals

1.3 Coordination Required

1.4 Coordination Documents

1.5 Coordination of Submittals

1.6 Coordination of Substitutions and Modifications

1.7 Observation of Work

1.8 Documentation

1.9 Equipment Start-Up

1.10 Inspection and Acceptance of Equipment

1.1 MECHANICAL & ELECTRICAL WORK COORDINATOR

1.2.1 Employ and pay for services of a person, technically qualified and experienced in field coordination for the type of mechanical and electrical work required for this Project, for the duration of the work.

1.2.2 Qualified person may be already part of staff, verify in writing, person's qualifications.

1.3 SUBMITTALS

1.3.1 Submit name, address and telephone number of coordinator and name of principle officer to Architect-Engineer for review of his/her qualifications.

1.3.2 Submit coordination drawings and schedule prior to submitting Shop Drawings, Product Data and Samples.

1.4 COORDINATION REQUIRED

1.4.1 Coordinate work of all applicable divisions.

1.4.2 Coordinate progress schedules, including dates for submittals and for delivery of products.

1.4.3 Conduct conferences among subcontractors and others concerned with the Work to establish and maintain coordination and schedules, and to resolve coordination materials in dispute.

1.4.4 Participate in progress meetings. Report on progress of Work to be adjusted under coordination requirements, and any required changes in schedules. Transmit minutes of meetings and reports to concerned parties.

1.5 COORDINATION DOCUMENTS

1.5.1 Prepare coordination drawings to organize installation of Products for efficient use of available space, for proper sequence of installation, and to identify potential conflicts.

1.5.2 Prepare a master schedule to identify responsibilities under each section of Divisions 1 through 16 of the Specifications for activities which directly relate to this work, including submittals and temporary utilities. Identify electrical power characteristics and control wiring required for each item of equipment.

1.5.3 Maintain documents for the duration of the Work, recording changes due to site instructions, modifications or adjustments.

1.5.4 After Architect-Engineer review or original and revised documents, reproduce and distribute copies to concerned parties.

1.6 COORDINATION OF SUBMITTALS

1.6.1 Review Shop Drawings, Product Data and Samples for compliance with Contract Documents and for coordination among work of all sections of the Project Manual. Transmit to Contractor for review, and then transmit to Architect-Engineer.

1.6.2 Check field dimensions and clearances and relationship to available space and anchors.

1.6.3 Check compatibility with equipment and Work of other sections, electrical characteristics, and operational control requirements.

1.6.4 Check motor voltages and control characteristics.

1.6.5 Coordinate controls, interlocks, wiring of pneumatic switches and relays.

1.6.6 Coordinate wiring and control diagrams.

1.6.7 Review the effect of any changes on work of other sections.

1.6.8 Verify and coordinate maintenance of record documents.

1.7 COORDINATION OF SUBSTITUTIONS & MODIFICATIONS

1.7.1 Review proposals and requests from subcontractors.

1.7.2 Verify compliance with Contract Documents and for compatibility with Work and Products of other sections.

1.7.3 Submit to Contractor with recommendation for action.

1.7.4 Coordinate with Sections 01600 and 1600a.

1.8 OBSERVATION OF WORK

1.8.1 Observe Work for compliance with Contract Documents.

1.8.2 Maintain a list of observed deficiencies and defects; promptly submit to contractor.

1.9 DOCUMENTATION

1.9.1 Observe and maintain a record of tests. Record:

a. Specification section number, product and name of subcontractor.

b. Name of testing agency and name of inspector.

c. Name of manufacturer's representative present.

d. Date, time and duration of tests.

e. Retesting required.

f. Type of test and results.

1.9.2 Assemble background documentation for dispute and claim settlement by Architect-Engineer.

1.9.3 Submit copies of documentation to Architect/Engineer upon request.

1.10 EQUIPMENT START-UP

1.10.1 Verify utilities, connections and controls are complete and equipment is in operable condition as required by Sections 01039, 01650, and 01700.

1.10.2 Observe start-up and adjustments; record time and date of start-up and results.

1.10.3 Observe equipment demonstrations to Owner; record times and additional information required for Operation and Maintenance Manuals.

1.10.4 Submit an approved Balance Report of HVAC System.

1.11 INSPECTION & ACCEPTANCE OF EQUIPMENT

1.11.1 Prior to inspection, verify that equipment if tested and operational and clean.

1.11.2 Assist Architect-Engineer with inspection. Prepare list of items to be completed and corrected.

2.1 PRODUCTS

3.1 EXECUTION

END OF SECTION

01050 FIELD ENGINEERING

01051 LAYOUT

1.1 Under the supervision and with the assistance of the Construction Manager, each Trade Contractor will be responsible for the layout of his particular portion of the work. Checking of layout and any assistance provided by the Construction Manager shall in no way be construed to relieve the Trade Contractors of their responsibilities for layout dimensions, tolerances, and accuracy of their work as set forth in the Contract Documents.

1.2 Each Trade Contractor shall carefully protect monuments, stakes, and benchmarks. If destroyed or disturbed by the Trade Contractor or his employees, the cost of replacing them shall be charged against the Trade Contractor and shall be deducted from the Trade Contractor's contract amount.

1.3 Except as otherwise noted, each Trade Contractor shall obtain his own field measurements and establish lines, grades, levels, and measurements shown on the drawings, and reconcile all measurements and conditions shown on the drawings with existing conditions at site, from the site survey provided and building corner indications and ground floor elevation designated by the Construction Manager.

1.4 Before custom fabricating any materials, the Trade Contractor shall verify all dimensions of any existing and new work, and shall be responsible for their accuracy. Any differences found shall be submitted to the Architect through the Construction Manager, for consideration before proceeding with the work. No extra compensation will be permitted because of differences between actual dimensions and measurements indicated on the project drawings.

END OF SECTION

01060 REGULATORY REQUIREMENTS

01061 APPLICABLE CODES

1.1 Reference section 00210 for the list of applicable codes.

01062 WAGES, LABOR & EQUAL EMPLOYMENT OPPORTUNITY

1.1 The Trade Contractor shall provide for labor needs from the ranks of working labor locally. The Trade Contractor shall enforce the same conditions upon all Trade Subcontractors engaged by the Trade Contractor for the performance of any portion of the work.

1.2 Successful bidders shall be required to subscribe to the principles of equal opportunity in its employment practices, and shall be required to enforce the same conditions upon all Trade Subcontractors engaged by the Trade Contractor for the performance of any portion of the work.

01063 FIRE HAZARD CLASSIFICATION

1.1 Fire hazard classifications for materials as specified in the technical specification shall be those established by publication in Current Building Materials List published by Underwriters' Laboratories, Inc., or certified to by notarized affidavit from Southwest Research Institute, or other agency acceptable to the State Construction Code Commission.

1.2 Where compliances are established by publication in Building Materials List, Trade Contractor shall so represent in writing to the Construction Manager. Where compliances are to be established by affidavit, Trade Contractor shall submit properly notarized affidavit that the material has been tested in accordance with requirements of ASTM E84, ASTM E119, or other specified standard, and found to qualify for the specified classifications. Affidavit shall state the name of the testing agency. The affidavit for testing is to be certified by the manufacturer for material and by the installer for installation.

1.3 Six copies of affidavits and other representations of compliance shall be submitted to the Construction Manager at time of shop drawing or sample submittal, whichever comes first.

1.4 In addition, the Construction Manager and Trade Contractor shall have the said materials inspected upon receipt, also before installation, and shall submit upon request prior to final acceptance of project, six copies of properly notarized affidavits by the Construction Manager and Trade Contractor as to the inspection (naming the inspector and other witnesses), certifying that the materials covered by previously submitted affidavits or other representations of compliance with the requirements for specified classifications were received at the jobsite properly labeled or otherwise certified to, and said materials were installed, and in a manner to in no way harm said compliances.

2. FIRE MARSHAL AFFIDAVITS

2.1 The Conditions of the Contract and Division 1 - General Requirements, are a part of this Section.

2.2 The requirements specified hereinafter refer to compliance with Codes and Regulations of governing authorities referred to in Article 4 of the General Conditions.

2.3 Submit in triplicate, notarized affidavits for the products required as specified in the various technical sections of the specifications. Affidavits shall be submitted to the appropriate field office responsible for the project. Affidavit shall be signed and notarized, and in the following format:

AFFIDAVIT

This is to certify that, (Name of Product) which was or will be furnished to (Company making Application of Product) for (Job or Project Name and Address) is the same in all respects in content, and specifications for mixing and/or application as the specimen tested by (Name of Laboratory) on their project or test number (Test Number) dated (Date of Test).

Flame Spread _____
Fuel Contributed _____
Smoke Developed _____

END OF SECTION

01070 ABBREVIATIONS & SYMBOLS

01071 LIST OF ABBREVIATIONS

ACI	American Concrete Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASTM	American Society for Testing Materials
BIM	Building Information Modeling
BOCA	Building Officials and Code Administrators
ICBO	International Conference of Building Officials
LEED	Leadership in Environmental and Energy Design (if applicable)
DOT	Department of Transportation
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
SMACNA	Sheet Metal & A/C Contractors National Association
UBC	Uniform Building Code
OSHA	Occupational Safety and Health Administration

END OF SECTION

01095 REFERENCE STANDARDS AND DEFINITIONS

1.1 RELATED DOCUMENTS

a. General provisions of the Contract, including General and Supplementary Conditions, other Division 1 Specification Sections and Drawings, apply to this Section.

1.2 DEFINITIONS

a. Basic Contract definitions are included in the General Conditions and Special Conditions.

b. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the drawings, other paragraphs or schedules in the specifications, and similar requirements in the Contract Documents. Where terms such as "shown", "noted", "scheduled" and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.

c. Regulation: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the work.

d. Furnish: The term "furnish" is used to mean "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation, and similar operations."

e. Install: The term "install" is used to describe operations at project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."

f. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use."

g. Installer: An "Installer" is the Contractor or an entity engaged by the Contractor, either as an employee, sub-contractor, or sub-sub-contractor, for performance of a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.

h. Unless otherwise indicated, the term "experienced" when used with the term "Installer" means having a minimum of 5 previous projects similar in size and scope to this project, being familiar with the precautions required, and having compiled with requirements of the authority having jurisdiction.

i. Trades: Use of titles such as "carpentry" is not intended to imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter". It also does not imply that requirements specified apply exclusively to tradespersons of the corresponding generic name.

j. Assignment of Specialists: Certain Sections of the Specifications require that specific construction activities shall be performed by specialists who are recognized experts in the operations to be performed. The specialists must be engaged for those activities, and assignments are requirements over which the Contractor has no choice or option.

Nevertheless, the ultimate responsibility for fulfilling Contract requirements remains with the Contractor.

This requirement shall not be interpreted to conflict with enforcement of building codes and similar regulations governing the work. It is also not intended to interfere with local trade union jurisdictional settlements and similar conventions.

k. Project Site: The space available to the Trade Contractors for performance of construction activities, either exclusively or in conjunction with others performing other work as part of the Project. The extent of the Project Site is shown on the drawings and may or may not be identical with the description of the land upon which the Project is to be built.

l. Testing Laboratories: A "testing Laboratory" is an independent entity engaged to perform specific inspections or tests, either at the Project Site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

1.3 SPECIFICATION FORMAT AND CONTENT EXPLANATION

a. Specification Format: The Specifications are organized into Divisions and Sections based on either the Construction Specifications Institute's 16-Division format or the MASTERFORMAT sections 020000-480000.

b. Specification Content: This Specification uses certain conventions in the use of language and the intended meaning of certain terms, words, and phrases when used in particular situations or circumstances. These conventions are explained as follows:

1) Abbreviated Language: Language used in Specifications and other Contract Documents is the abbreviated type. Implied words and meanings will be appropriately interpreted. Singular words will be interpreted as plural and plural words interpreted as singular where applicable and the full context of the Contract Documents so indicates.

2) Imperative and streamlined language is used generally in the Specifications. Requirements expressed in the imperative mood are to be performed by the Contractor. At certain locations in the text, for clarity, subjective language is used to describe responsibilities that must be fulfilled indirectly by the Contractor, or by others when so noted.

3) The words "shall be" shall be included by inference wherever a colon (:) is used within a sentence or phrase.

c. Summary References: The Summary Article of each Specification Section includes references to Work Included, Related Work Specified Elsewhere, Products Furnished but not Installed by this Section, and similar phrases. These listings are provided as a guide to the Contractor to assist the Contractor in locating related information within the Specification. No guarantee regarding the absolute completeness of these references is intended or may be inferred nor shall the presence, or lack thereof, of any reference relieve the Contractor of the final responsibility for proper completion of the work.

1.4 INDUSTRY STANDARDS

a. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents. Such standards are made a part of the Contract Documents by reference.

b. Publication Dates: Where the date of issue of a referenced standard is not specified, comply with the latest referenced standard in effect at the time of Bid Opening.

c. Conflicting Requirements: Where compliance with two or more standards is specified, and the standards establish different or conflicting requirements for minimum quantities or quality levels, refer requirements that are different, but apparently equal, and uncertainties to the Architect for a decision before proceeding.

d. Copies of Standards: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to that entity's construction activity. Copies of applicable standards are not bound with the Contract Documents.

1) Where copies of standards are needed for performance of a required construction activity, the Contractor shall obtain copies directly from the publication source and maintain these standards, for reference by the Contractor, and Architect, in a convenient location within the temporary office.

e. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where acronyms or abbreviations are used in the Project Manual, they mean the recognized name of the Trade organization, standards generating organization, authority having jurisdiction, or other entity applicable. Refer to the "Encyclopedia of Associations", published by Gale Research Company, available in most libraries.

1.5 SUBMITTALS

a. Permits, Licenses, and Certificates: For the Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, and similar documents, correspondence, and records established in conjunction with compliance with standards and regulations bearing upon performance of the work.

PART 2 PRODUCTS

Not applicable.

PART 3 EXECUTION

Not applicable.

END OF SECTION

01100 ALTERNATES

1.1 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

1.2 DEFINITIONS

1.2.1 Voluntary and Mandatory Alternates are defined as alternate products, materials, equipment, installations or systems for the work, which may, at the Owner's option, be selected to either add to or delete from the scope of the project.

1.2.2 Alternates may, or may not, substantially change scope and general character of the work, and must not be confused with "allowances", "unit prices", "change orders", "substitutions", and other similar provisions.

1.3 COORDINATION

1.3.1 Coordinate pertinent related work and modify surrounding work as required to properly integrate the work under each Alternate, and to provide the complete construction required by the plans and specifications. Each Alternate includes all related work required to provide the work described in the individual Alternate.

1.4 DESCRIPTION OF ALTERNATES

1.4.1 Refer to Section 00210 for a description of the basic change added to or deleted from the scope of the project.

1.4.2 The Owner reserves the right to select any Alternate following submission of the bid. If selected subsequent to the award and execution of the Agreement, the Alternate will be affected by Change Order and the sole consideration shall be the price quoted in the bid.

1.4.3 Each contractor should review each alternate and include a "deduct or add" amount on the trade contract proposal form. At the end of each alternate is a summary of the Work Categories affected by the alternate.

1.4.4 RELATED DOCUMENTS

a. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.4.5 DESCRIPTION OF REQUIREMENTS:

a. Definition: An alternate is an amount proposed by Bidders and stated on the Bid Form that will be added to or deducted from Base Bid amount if the Owner decides to accept a corresponding change in either scope of work or in products, materials, equipment, systems or installation methods described in Contract Documents. Alternate Bid Pricing shall be firm for 90 days from date of award.

b. Coordination: Coordinate related work and modify or adjust adjacent work as required to ensure that work affected by each accepted alternate is complete and fully integrated into the project.

c. Notification: Immediately following award of Contract, prepare and distribute to each party involved, notification of the status of each alternate. Indicate whether alternates have been accepted, rejected or deferred for construction at a later date. Include a complete description of negotiated modifications to alternates, if any.

d. Schedule: A "Schedule of Alternates" is included in Section 00210. Specification sections referenced in the Schedule contain requirements for materials and methods necessary to achieve the work described under each alternate.

1) Include as part of each alternate, miscellaneous devices, appurtenances and similar items incidental to or required for a complete installation whether or not mentioned as part of the alternate.

01110 VOLUNTARY ALTERNATES

1.1 Bidding of Voluntary Alternates is encouraged. It shall be understood that Voluntary Alternates cannot be considered as a basis for determining a low bid. Contractor may only be determined low bidder based upon the Contract Documents and specified bid alternates in Section 01100.

END OF SECTION

01150 MEASUREMENT AND PAYMENTS

1.1 DESCRIPTION

This Section describes the means and methods required for payment for work performed as an extra to the Contract.

1.2 CHANGES IN THE WORK

1.2.1 The Owner and Architect reserve the right to make changes in the work without notice to sureties or in any way rendering the Contract void.

1.2.2 Changes in the work will be described in Supplemental Instruction (SI), Construction Change Directive (CCD), Bulletins, Proposal Request, or Field Orders issued by the Architect or Construction Manager in accordance with the General Conditions and the Supplementary Conditions, and with procedures described in this Section.

1.2.3 Unless specified otherwise, Bulletins and Proposal Requests are not authorization to proceed with the changes described, and Supplemental Instructions, Construction Change Directives or Field Orders countersigned by the Owner are authorization to proceed. The Trade Contractor will be authorized to proceed with extra work by an approved quotation or signed Field Order.

1.2.4 No claims for additional compensation will be considered for changes in the work unless authorization to proceed has been given by a signed Construction Change Directive**,** Field Order or a Change Order issued by the Construction Manager.

1.2.5 Promptly submit to the Construction Manager, a written detailed quotation of the additional cost, credit or statement noting no change upon the receipt of each Construction Change Directive, Bulletin or Field Order.

1.2.6 Each quotation is subject to approval of the Construction Manager, Architect and the Owner, after which a Change Order will be issued to modify each Trade Contract.

1.2.7 Regard each Construction Change Directive, Bulletin or Field Order as a complete unit and enumerate in detail as to labor, materials and related item in the quotation. Provide additional information as requested by the Construction Manager, Architect and/or Owner.

1.2.8 Proceed promptly in accordance with, and upon receipt of a Change Order. The Contract Sum will be adjusted in accordance with pricing methods described in the General Conditions or as modified by the Supplementary Conditions and as specified in the contract.

END OF SECTION

01200 PROJECT MEETINGS

01215 PRE-CONSTRUCTION SITE INSPECTION

1.1 Each Trade Contractor shall be held to have visited the site of the proposed work before submitting his proposal and to have familiarized himself with all existing conditions affecting the execution of his work in this project. No allowance or extra consideration on behalf of the Trade Contractor will subsequently be made by reason of failure to observe the site conditions, nor on behalf of any subcontractor for the same reason.

01225 PROGRESS MEETINGS

1.1 At regular intervals, the Construction Manager shall hold meetings at the jobsite with the representatives of the various Trade Contractors engaged on the project, to coordinate the progress of the work. The Construction Manager shall notify all parties required to attend, the time and place of these meetings.

1.2 The Construction Manager shall conduct and keep a written record of all such meetings, and distribute copies of them to the Architect, Owner, and all Trade Contractors interested in the matters covered.

1.3 All Trade Contractors shall furnish to the Construction Manager's Field Representative, all available information concerning the conditions and progress of their work, including manpower used on a daily basis.

END OF SECTION

013000 SUBMITTALS

1. SHOP DRAWINGS, PRODUCT DATA & SAMPLES

1.1 DESCRIPTION OF REQUIREMENTS

A. GENERAL:

a. This Section specifies requirements for submittals including shop drawings, product data, samples and other miscellaneous work related submittals. Shop drawings, product data samples and other work related submittals are required to amplify, expand and coordinate the information contained in the Contract Documents.

b. Shop drawings are technical drawings and data that have been specially prepared for this project, including but not limited to the following items:

- Fabrication and installation drawings.
- Setting diagrams.
- Shopwork manufacturing instructions.
- Templates.
- Patterns.
- Coordination drawings (for use on site).
- Schedules.
- Design mix formulas.
- Contractor's engineering calculations.

c. Standard information prepared without specific reference to a project is not considered to be shop drawings.

d. Product data includes standard printed information on manufactured products that has not been specially prepared for this project, including but not limited to the following items:

- Manufacturer's product specifications & installation instructions.
- Standard color charts.
- Catalog cuts.
- Roughing-in diagram and templates.
- Standard wiring diagrams.
- Printed performance curves.
- Operational range diagrams.
- Mill reports.
- Standard product operating and maintenance manuals.

e. Samples are physical examples of work, including but not limited to the following items:

- Partial sections of manufactured or fabricated work.
- Small cuts or containers of materials.
- Complete units of repetitively used materials.

- Swatches showing color, texture and pattern.
- Color range sets.
- Units of work to be used for independent inspection and testing.

a. Mock-ups are special forms of samples, which are too large or otherwise inconvenient for handling in the manner specified for transmittal or sample submittals.

b. Miscellaneous submittals are work related, non-administrative submittals that do not fit in the three previous categories, including, but not limited to the following:

- Specially prepared and standard printed warranties.
- Maintenance agreements.
- Workmanship bonds.
- Survey data and reports.
- Project photographs.
- Testing and certification reports.
- Record drawings.
- Field measurement data.
- Operating and maintenance manuals.
- Keys and other security protection devices.
- Overrun stock.

1.2 SUBMITTAL PROCEDURES

1.2.1 Coordination: Coordinate the preparation and processing of submittals with the performance of the work. Coordinate each separate submittal with other submittals and related activities such as testing, purchasing, fabrication, delivery and similar activities that require sequential activity.

Coordinate the submittal of different units of interrelated work so that one submittal will not be delayed by the Architect/Engineer's need to review a related submittal.

The Architect/Engineer reserves the right to withhold action on any submittal requiring coordination with other submittals until related submittals are forthcoming.

1.2.2 Listing: Prepare a separate listing showing principal submittals and their initial submittal dates as required for coordination of the work. Organize the listing by the related specification number sequence. Submit the listing within 30 days of the date of commencement of the work.

1.2.3 Coordination of Submittal Times: Prepare and transmit each submittal to the Construction Manager sufficiently in advance of the scheduled performance of related work and other applicable activities.

Transmit different kinds of submittals for the same unit of work so that processing will not be delayed by the Architect/Engineer's need to review submittals concurrently for coordination.

1.2.4 Review Time: Allow sufficient time so that the installation will not be delayed as a result

of the time required to properly process submittals, including time for resubmittal, if necessary.

a. Allow 15 working days for the Architect/Engineer's initial processing of each submittal. Allow a longer time period where processing must be delayed for coordination with subsequent submittals. The Architect/ Engineer will advise the Construction Manager promptly when it is determined that a submittal being processed must be delayed for coordination.

b. Allow 10 working days for reprocessing each submittal.

c. No extension of time will be authorized because of the Trade Contractor's failure to transmit submittals to the Construction Manager sufficiently in advance of the work.

1.2.5 Submittal Transmittal: Transmit each submittal from the Trade Contractor to the Construction Manager, by use of a submittal form. Submittals received from sources other than the Trade Contractor will be returned to the sender "without action".

1.2.6 Submittal Form: The form required to be used for transmittal of submittals will be provided to the Trade Contractor by the Construction Manager.

a. Record relevant information and requests for data on the submittal form. On the form, or on a separate sheet attached to the form, record deviations from the requirements of the Contract Documents, if any, including minor variations and limitations.

1.3 SPECIFIC SUBMITTAL REQUIREMENTS

1.3.1 General: Specific submittal requirements for individual units of work are specified in the applicable specification section. Comply with the requirements specified herein for each type of submittal.

1.4 SHOP DRAWINGS

1.4.1 Shop Drawings: Information required on shop drawings includes, dimensions, identification of specific products and materials which are included in the work compliance with specified standards and notations of coordination requirements with other work. Provide special notation of dimensions that have been established by field measurement. Highlight, encircle or otherwise indicate deviations from the contract documents on the shop drawings.

1.4.2 Coordination Drawings: Provide coordination drawings where required for the integration of the work, including work first shown in detail on shop drawings or product data. Show sequencing and relationship of separate units of work, which must interface in a restricted manner to fit in the space provided, or function as indicated. Coordination drawings are considered shop drawings and must be definitive in nature.

1.4.3 Do not distribute shop drawing copies without an appropriate final "Action" marking by

the Architect/Engineer to be used in connection with the work.

1.4.4 PREPARATION: Submit newly prepared information, drawn to accurate scale. Indicate the name of the firm that prepared each shop drawing and provide appropriate project identification in the title block.

1.4.5 Do not reproduce contract documents as the basis of shop drawings.

1.4.6 SUBMITTAL:

a. One of the prints returned will be marked up and maintained by the Trade Contractor as a "Record Document".

1.5 PRODUCT DATA

1.5.1 PRODUCT DATA: General information required specifically as product data includes manufacturer's standard printed recommendations for application and use, compliance with recognized standards of trade associations and testing agencies, and the application of their labels and seals (if any), special notation of dimensions which have been verified by way of field measurement, and special coordination requirements for interfacing the material, product or system with other work.

1.5.2 PREPARATION: Collect required product data into a single submittal for each unit of work or system. Mark each copy to show which choices and options are applicable to the project. Where product data has been printed to include information on several similar products, some of which are not required for use on the project, or are not included in this submittal, mark the copies to show clearly that such information is not applicable.

1.5.3 SUBMITTALS: Product data submittal is required for information and record and to determine that the products, materials and systems comply with the provisions of the contract documents.

1.5.4 SUBMITTAL: The Architect/Engineer will retain one copy, the Owner's Representative one copy and will return the others marked with "Action" and corrections as required.

a. Do not submit product data or allow its use on the project, until compliance with the requirements of the contract documents has been confirmed by the Trade Contractor.

1.5.5 FINAL DISTRIBUTION: Furnish copies of product data to trade contractors, suppliers, fabricators, manufacturers, installers, governing authorities and others as required for proper performance of the work.

1.5.6 INSTALLATION COPY: Do not proceed with installation of materials, products and systems until a copy of product data applicable to the installation is in the possession of the installer. Do not permit the use of unmarked copies of product data in connection with the performance of the work.

1.6 SAMPLES

1.7.1 Submit samples for the Architect/Engineer's visual review of general generic kind, color, pattern, and texture, and for a final check of the coordination of these characteristics with other related elements of the work.

Samples are also submitted for quality control comparison of these characteristics between the final sample submittal and the actual work as it is delivered and installed.

a. Refer to individual sections of these specifications for additional sample requirements.

b. Documentation required specifically for sample submittals includes a generic description of the sample, the sample source, the product name or manufacturer, compliance with governing regulations and recognized standards.

1.7.2 PREPARATION: Where possible provide samples that are physically identical with the proposed material to be incorporated in the work; provide full scale, fully fabricated samples, cured and finished in the manner specified. Where variations in color, pattern, or texture are inherent in the material represented by the sample, submit not less than 4 units, which show the approximate limits of variations. Where samples are specified for the Architect/Engineer's selection of color, texture or pattern, submit a full set of available choices for the material or product.

a. Refer to individual sections of these specifications for samples, which, because of their relatively high cost or other special considerations, are intended to be returned to the Contractor for incorporation in the work. Such samples must be in an undamaged condition at the time of use. On the transmittal form to the Architect/Engineer, indicate such special requests regarding the disposition of sample submittals.

1.7.3 DISTRIBUTION OF SAMPLES: Maintain the final submittal sets of samples, last returned by the Architect/Engineer, at the project site, available for quality control comparisons throughout the course of performing the work. In addition, final submittal sets may be used to obtain final acceptance of the work associated with each set.

Prepare and distribute additional sets of samples to subcontractors, suppliers, fabricators, manufacturers, installers, governing authorities, and others as required for proper performance of the work. Show final distribution on transmittal forms.

a. Mockups and similar samples specified in individual work sections are special types of samples. Comply with sample submittal requirements to the fullest extent possible. Process transmittal forms to provide a record of activity.

1.7 MISCELLANEOUS SUBMITTALS

1.7.1 INSPECTION AND TEST REPORTS: Process inspection and test reports in accordance with Product Data requirements.

1.7.2 WARRANTIES: Refer to Section 01740 for specific general requirements on warranties,

product bonds, workmanship bonds and maintenance agreements. In addition to copies desired for the Trade Contractor's use, furnish at least 2 executed copies of such warranties, bonds or agreements. Provide at least 2 additional copies where required for maintenance manuals.

1.7.3 STANDARDS: Where submittal of a copy of standards is indicated, submit at least 2 copies of standards for the Architect/Engineer's use. Where workmanship, whether at the project site or elsewhere is governed by a standard, furnish additional copies of the standard to fabricators, installers and others involved in the performance of the work.

1.7.4 CLOSEOUT SUBMITTALS: Refer to Section 01700 and to individual sections of these specifications for specific submittal requirements of project closeout information, materials, tools, and similar items.

1.7.5 RECORD DOCUMENTS: Furnish set of original documents as maintained on the project site. Along with original marked up record drawings provide electronic copies of marked up drawings.

1.7.6 OPERATING AND MAINTENANCE DATA: Unless specified otherwise, furnish at least 4 bound copies of operating data and maintenance manuals, and one electronic copy.

1.7.7 MATERIALS AND TOOLS: Refer to individual sections of these specifications for required quantities of spare parts, extra and overrun stock, maintenance tools and devices, keys, and similar physical units to be submitted.

1.7.8 GENERAL DISTRIBUTION: Provide additional distribution of submittals to subcontractors, suppliers, fabricators, installers, governing authorities, and others as necessary for the proper performance of the work. Include such additional copies of submittals in the transmittal to the Architect/ Engineer where the submittals are required to receive "Action" marking before final distribution. Record distributions on transmittal forms.

1.8 ARCHITECT/ENGINEER'S ACTION:

1.8.1 GENERAL: The Architect/Engineer will review each submittal, mark with appropriate "Action", and where possible return within 10 working days of receipt. Where the submittal must be held for coordination the Architect/Engineer will so advise the Trade Contractor via the Construction Manager without delay.

1.8.2 ACTION STAMP: The Architect/Engineer will stamp each submittal to be returned with a self explanatory action stamp, appropriately marked to indicate whether the submittal returned is for unrestricted use, final but restricted use (as marked), must be revised and resubmitted (use not permitted) or without action (as explained on the transmittal form). Refer to Section 00210 for action stamp markings.

1.8.3 FINAL UNRESTRICTED RELEASE: Where the submittals are marked as follows, the work may proceed provided it complies with the requirements of the contract documents; acceptance of the work will depend upon that compliance.

1.8.4 MAKE CORRECTIONS NOTED: When the submittals are marked as follows, the work may proceed provided it complies with both the Architect's/ Engineer's notations or corrections on the submittal and with the requirements of the contract documents; acceptance of the work will depend on that compliance.

1.8.5 REVISE AND RESUBMIT: When the submittals are marked as follows, the work may proceed provided it complies with both the Architect's/Engineer's notations or corrections on the submittal and with the requirements of the contract documents, acceptance of the work will depend on that compliance. Revise the submittal and resubmit for Architect's/Engineer's verification of compliance.

1.8.6 REJECTED: When the submittal is marked as follows, do not proceed with the work including purchasing, fabrication, delivery, or other activity. Revise the submittal or prepare a new submittal in activity. Revise the submittal or prepare a new submittal in accordance with the Architect's/Engineer's notations stating the reasons for returning the submittal; resubmit the submittal without delay. Repeat if necessary to obtain a different action marking. Do not permit submittals with the following marking to be used at the project site, or elsewhere where work is in progress.

END OF SECTION

01310 CONSTRUCTION SCHEDULES

1.1 EXECUTION OF THE WORK

1.2 CONSTRUCTION PLANNING

Within five (5) days after the award of each Trade Contract, all Trade Contractors shall submit the following scheduling information:

1.2.1 A Procurement Status Report, in a format acceptable to the Construction Manager, which shall itemize all material and equipment, submittal and review requirements, fabrication and delivery lead times, and delivery requirements needed to meet the Trade Contractor's schedule as well as the overall project schedule.

1.2.2 Each Trade Contractor shall submit their own detailed schedule, in a format acceptable to the Construction Manager, which incorporates: the procurement information of Article 1.1.1-above, all known interfacing of other trades, the Trade Contractor's anticipated durations, and all other information the Trade Contractor feels is necessary to identify their requirements for the Construction Manager to coordinate with the Construction Manager's direction and scheduling.

1.3 CONSTRUCTION SCHEDULING

1.3.1 A detailed Construction Schedule will be prepared with the Trade Contractor's input immediately after award of bids and submittal of the above information. Section 00200 provides the "preliminary construction schedule" which describes the approximate durations of sequence of the projects. The completion dates provided are firm and must be achieved. It is intended that all bidders agree to accept the final schedule, and acknowledge that other Trade Contractor's work is paced by, or dependent upon, the various activities being able to commence and proceed with associated activities as scheduled. The approved Construction Schedule shall be regarded as a firm contractual commitment by all parties affected therein.

1.3.2 All Trade Contractors and their Trade Subcontractors recognize and shall accept modifications to the schedule which are reasonable, in the opinion of the Construction Manager for the general interest of the project, as a result of allowable time extensions (formally or informally approved) in any contract, and such modifications are inherent to the construction process and shall not qualify as a basis for extra compensation from the Construction Manager or Owner."

1.3.3 If a CPM network schedule is used to coordinate the work of the project, start and finish dates for each work activity will be furnished to the Trade Contractor to schedule his work. Periodically, these dates will be revised to reflect changed project conditions. The Construction Manager will attempt to schedule the start of the work of any Trade Contractor on the date for the activity, and the Trade Contractor agrees to cooperate in following that direction.

1.3.4 If it is apparent that a Trade Contractor is not going to complete his work in the time allotted, said Contractor must notify the Construction Manager within five (5) days after publication of the schedule. Adjustments may be made to accommodate a Trade

Contractor, if the above notification is received and it is within the dates established. Otherwise the schedule shall be deemed accepted by all parties and become the schedule for the Trade Contractor. Each Trade Contractor will be responsible to be familiar with the schedule and how it will effect or modify his operations, including his coordination with the activities of other Trade Contractors.

1.3.5 It is expressly agreed that time is of the essence for the completion of work under his contract, and the Trade Contractor agrees to perform the work within the time and in the manner specified or within the time extensions the Owner may grant; provided, however, that the Trade Contractor may be liable for any damages suffered by the Owner due to failure of the Trade Contractor to perform the specified work within the specified time.

1.3.6 The Trade Contractor, within five (5) days after being notified to commence work, agrees to commence work in the field of such points as the Construction Manager may designate, and to continue diligently to perform the work, and to fully complete all of his work to the satisfaction of the Construction Manager and Owner. The work shall be carried to completion with utmost speed.

1.3.7 If the Trade Contractor delays progress for any reason other than those allowed by the General Conditions, and refuses to adequately man the project or to work overtime, the Construction Manager may accelerate the work of subsequent Trade Contractors and backcharge all costs to the late Trade Contractor. All direction in this regard will be given in writing to the Trade Contractor.

END OF SECTION

01370 SCHEDULE OF VALUES

1.1 REQUIREMENTS: The Christman Company requires that all Pay Applications and related information (Schedule of Values) be processed through its proprietary Trade Contractor Portal. Trade Contractor agrees to comply with the requirements of the portal. This is your only method of submitting a payment application.

1.1.1 There is No Fee associated with using the Portal.

1.1.2 This also includes Compliance related information such as the Sworn Statement, supporting Waivers, and Insurance Certificates.

END OF SECTION

01400 QUALITY CONTROL

01410 TESTING LABORATORY SERVICES

1.1 TESTING LABORATORY SERVICES

1.1.1 GENERAL: All work (materials and installation procedures) as indicated in specifications, shall be tested and inspected by an independent testing and inspection agency, approved by the Architect/Engineer to provide the quality control requirements in accordance with these specifications. Results of these tests and inspections when performed in accordance with these specifications will not be disputed by either party. Failure of the Trade Contractor to provide quality control in accordance with this specification may result in the replacement of the work at the Trade Contractor's expense.

1.1.2 Owner Provided Testing – Refer to Section 00210 and work category descriptions for testing services provided by the Owner, if applicable.

1.2 TRADE CONTRACTOR'S RESPONSIBILITY

1.2.1 Unless identified otherwise, Trade Contractors are responsible for testing and/or balancing as defined in their work categories and/or designated specification sections.

1.3 TESTING & INSPECTION AGENCY RESPONSIBILITIES

1.3.1 Perform all testing and inspection of the work in accordance with these specifications. Furnish qualified personnel and sufficient equipment in a timely manner when required by the Trade Contractor and/or Architect/Engineer to perform all testing and inspection in accordance with these specifications. Provide written reports, electronically and at least one hard copy, in a timely manner of the work tested and inspected. The reports shall include complete material test results and for in place material, a sketch showing the exact location where the test was taken on the project site. The inspection and testing agency and its representatives are not authorized to revoke, alter, relax, enlarge or release any requirements of the contract documents, nor to approve or accept any portion of the work.

Work will be checked by representatives of the testing agencies as it progresses, but failure to detect any defective work or product will not in any way prevent later rejection when such defect is discovered, nor will it obligate the Owner to final acceptance. When it appears that the work or product furnished is in non-conformance with the contract documents, the representative of the testing agency will direct the attention of the Architect/Engineer and Trade Contractor to such non- conformance.

1.4 AUTHORITY OF THE ARCHITECT/ENGINEER

1.4.1 The Architect/Engineer may order from time to time additional tests and inspection beyond those required, if in his opinion, the subject work may not be meeting specification. The cost for these tests and inspections shall be born by the Trade

Contractor if results indicate that work was NOT within the project specifications. The Architect/Engineer may terminate the testing and inspection agency. The Trade Contractor shall then furnish to Construction Manager the name of an additional agency for approval. The Architect/Engineer may perform quality control tests and inspections.

END OF SECTION

Indoor Air Quality (IAQ) Management Plan - During Construction

Objective

Protect indoor air quality during construction for the safety of construction workers and for the assurance of a high quality indoor environment after building occupancy.

Plan

- Materials have been specified to minimize indoor air pollutants from material off-gassing. Subcontractors are to make every effort to meet the specified requirements for materials.
- Those materials and construction practices that do not specifically meet the requirements of the specifications, should be of the lowest toxicity available in the industry.
- For those materials and construction practices that introduce air quality concerns, use the following procedures to help prevent buildup of contaminates to the indoor environment.

Definitions

- Absorptive Materials: Gypsum board, acoustical ceiling tile and panels, carpet and carpet tile, materials containing/wrapped in fabrics, fibrous insulation/materials and other materials containing materials with similar absorptive characteristics.
- Contaminants: Gases (i.e. carbon monoxide, acetylene), paint, sealants and coating vapors, regulated pollutants, airborne mold and mildew, products that emit volatile organic compounds during installation, drying, or curing.
- Particulates: Dust, dirt, smoke, concrete dust, masonry dust, drywall dust, wood dust, silica, fiberglass and other airborne solid matter.

HVAC Protection

- Mechanical systems protection – all ductwork not being worked on should be covered to prevent the infiltration of particulate matter. Care should also be given to protect ductwork from collection of particulate matter during delivery to the site. All mechanical equipment that has openings where particulate matter could enter, should be covered at all times.
- If possible, avoid using permanently installed air handlers for temporary heating/cooling during construction – particularly during demolition.
- Do not store construction or waste materials in the mechanical room.
- Use temporary filtration media during construction to protect HVAC at each return air grille; filtration media shall have a Minimum Efficiency Reporting Value (MERV) of 8 as determined by ASHRAE 52.2 – 1999. Isolate the return side of the HVAC system from the surrounding environment as much as possible. Return side shall have the heaviest work areas dampered off and all return system openings sealed with plastic. Return side shall be shut down whenever possible during heavy construction and demolition.
- When the system is off, all supply ducts, equipment and openings should be sealed with plastic for further protection.
- Provide continuous ventilation rate of one air change per hour minimum during construction. Provide additional ventilation as may be necessary to protect workers' health and avoid the

accumulation of volatile compounds, dust and other harmful airborne contamination.
- Filtration media must have a Minimum Efficiency Reporting Value (MERV) of 8.
- Maintain a list, and cut sheet, of each air filter used during construction and at the end of construction. Include the MERV value, manufacturer name and model number.

Source Control
- Subcontractors to use low emitting products as specified. When limited resources are available, materials should be used that have the low toxicity emissions available.
- Use electrically powered equipment when feasible and switch from diesel to bottled gas for equipment such as generators or fork lifts.
- High levels of contaminant odor generated during removal of contaminated soils - consult Construction Manager and testing consultant upon first discovery of a contaminant odor. Respirators may need to be worn.
- Gaseous vapors generated during temporary heating operations – contractors to utilize explosive gas detectors that detect harmful levels of carbon monoxide, propane, natural gas, and smoke. Use electric or steam heaters for temporary heat when possible.
- Concrete floor sealing, block sealing and waterproofing - utilize fans, open windows, and respirators.
- Other- Allow sufficient time for dissipation of odor after installation of materials with elevated concentrations of VOC's and other moisture related/containing materials (i.e. fluid applied coatings, adhesives).
- Exhaust pollution sources to the outside through an available exhaust system or portable fan vented to the outside. Depending on the nature of the material and the location of the exhaust, special filtration may or may not be necessary.
- If exhausting the pollution sources is not feasible, the use of a portable air cleaner may be effective.

Pathway Interruption
- Erect barriers to contain the construction area. The barriers should be selected based upon the worst case contributor to dust or odor escaping from the site.
- Locate trash dumpsters, recycling centers and pollutions sources at reasonable distances from the site, so as not to affect the air quality of the surrounding areas.
- Depending on the weather conditions, ventilate using 100% outside air to exhaust contaminated air directly to the outside during installation of VOC-emitting materials.
- Depressurize the work area allowing the air pressure differential between construction and clean areas to contain dust and odors.

Housekeeping
- Isolate areas with high particulate concentration using solid physical barriers from floor to ceiling (plastic sheeting or similar).
- Asbestos abatement- A certified abatement firm and testing consultant will be hired to handle these situations. No trades are to be present in areas while abatement activities are taking place.

Areas being abated shall be separated from trades/Owner occupants by a solid physical barrier.

- Control dust and particulate concentration with wetting agents or sweeping compounds.
- If vacuum cleaners are being used for cleaning activities, use high efficiency particulate air filters in them.
- Remove spills of high VOC-emitting materials immediately.
- Use low-toxic cleaning supplies for surfaces, equipment and worker's personal use.
- Do not allow water to accumulate in the building envelope or anywhere on-site. Take care to remove the accumulated water as soon as possible and disinfect the area if necessary.
- Do not install any building materials that have become wet. If building materials do become wet then dry the materials out completely before they are covered up. Failure to do this will result in harmful mold growth which will be very expensive to remediate after the fact.
- When performing sanding operations for gypsum board assemblies, provide the following protection:

  1. Isolate the space
  2. Provide plastic sheet separation during sanding
  3. Close and seal all air system devices and ductwork
  4. Sequence construction to avoid contamination of other spaces with gypsum dust
  5. Provide worker protection

Scheduling

- Consult manufacturers for appropriate dry out times of materials prior to arrival on site. Factory aging of materials with strong odor emissions should be considered prior to delivery of materials on-site.
- Absorptive materials should be sequenced to arrive on-site when moisture and humidity levels are at acceptable levels based upon manufacturer's written/acceptable requirements.
- Products that do not meet the specified requirements, due to limited availability of materials, should be stored in dry, well ventilated areas for odor dissipation (off-gassing/conditioning).
- If absorbent materials must be stored in high humidity on site, protect absorbent materials with an impermeable moisture barrier, preferably a barrier containing recycled content.
- Upon completion of construction, replace all filtration media immediately prior to occupancy.
- After construction ends consideration should be given for conducting a baseline indoor air quality testing procedure for the affected space in the building.

Building Flush Out

- The Construction Manager, with the help of the Mechanical and Controls Contractors, will conduct a building flush out with new filtration media at 100% outside air after construction ends and prior to testing. The building flush out shall comply with the latest LEED requirements for the *Construction IAQ Management Plan – Before Occupancy*

Management & Enforcement of Plan

Construction Manager:

Superintendent shall give a copy of this plan to all subcontractors and shall reinforce the requirements of this plan on a daily basis and reserves the right to modify or change the plan at his or her discretion based on the current safety situation of the site. A testing consultant will be hired to monitor and report air contaminants and ventilation effectiveness at the discretion of the Superintendent. Project Engineer will support Superintendent in duct protection inspections throughout building.

Photo Documentation:
The Project Superintendent or Project Engineer shall document implementation of the IAQ Plan by taking at least 6 photos on at least 3 different occasions throughout the project. These photos should show each of the IAQ strategies described in this plan.

Architect:
Review compliance with plan during weekly site visits.

Owner:
Reserves the right at any time to verify compliance and request a team meeting to review project safety goals at his/her discretion.

Resources:
These guidelines were developed through referencing the SMACNA IAQ Guidelines for Occupied Buildings under Construction and the USGBC LEED-NC for New Construction Reference Guide.

- www.smacna.org
- www.usgbc.org

01500 TEMPORARY FACILITIES

1.1 DESCRIPTION OF REQUIREMENTS

1.1.1 This section specifies requirements for temporary services and facilities, including such items as temporary utility services, temporary construction and support facilities, and project security and protection. Refer to Section 00210 for additional requirements.

1.1.2 USE CHARGES: No cost or usage charges for temporary services or facilities are chargeable to the Owner or Architect/Engineer. The Construction Manager is responsible for these charges where indicated. In all other cases the Trade Contractor requiring same is responsible for the charges incurred. Cost or use charges for temporary services or facilities will not be accepted as a basis of claims for a change order.

1.2 PROTECTION OF EXISTING FACILITIES

1.2.1 Each Trade Contractor shall provide and maintain proper shoring and bracing for existing underground utilities, sewers, and building foundations encountered during his excavation work, to protect them from collapse or other type of damage until such time as they are to be removed, incorporated into the new work, or can be properly backfilled upon completion of new work.

1.2.2 Each Trade Contractor shall provide and maintain proper shoring and bracing for existing structures and finishes encountered during the execution of his work to protect from collapse or other type of damage until such time as they are to be removed, incorporated into the new work, or can be properly backfilled upon completion of new work.

1.2.3 Each Trade Contractor shall provide and maintain temporary protection for new and existing work during the execution of his work to protect from dirt and damage. Any damage to new and/or existing work resulting from the lack of or inadequate temporary protection shall be this contractor's responsibility to restore.

01510 TEMPORARY UTILITIES

1.1 TEMPORARY ELECTRICAL POWER & LIGHTING

Unless identified otherwise, the following provisions shall apply:

1.1.1 The temporary electrical power and lighting will be installed and maintained by the Electrical Trade Contractor (WC 28). Refer to Section 00210 to verify if the Owner shall pay for all power consumed for the temporary electrical service.

1.1.2 All Trade Contractors shall obtain the power for their temporary electric requirements from the existing power source available on the site. All necessary lugs, transformers, disconnect switches, fuses, cable, posts, ground fault interrupters, etc., required for connection to the power source and distribution, including wires, cable, supports, etc., shall be provided by Trade Contractor, all as coordinated and approved by the Construction Manager. The Owner shall pay for all reasonable amounts of power consumed for the temporary electrical service. Electric heaters will not be allowed for heating temporary trailers and offices.

1.1.3 Any electrical requirements for power or lighting beyond those listed in this paragraph shall be the responsibility of the Trade Contractor requiring them.

1.1.4 Overtime work requiring standby electricians shall be at the expense of the Trade Contractor requiring same. Installation of temporary electrical power and lighting shall be as scheduled by the Construction Manager.

1.1.5 Electric welder machines will not be allowed to be used without the express permission and approval of the Construction Manager and Owner. The Trade Contractor would have to pay for all equipment and materials required to provide the distribution and power supply if permission were granted to use electric welders, all as coordinated and approved by the Construction Manager.

1.1.6 All temporary electrical installations shall be in compliance with the latest National Electrical Code or OSHA, whichever is more stringent.

1.2 TEMPORARY HEAT

1.2.1 Unless identified otherwise, all equipment and labor for temporary heat after building enclosure shall be furnished by the Mechanical Trade Contractor (WC 27). Refer to Section 00210 to verify if energy will be supplied by the Owner when the heating equipment is connected to the existing power system.

1.3 COLD WEATHER PROTECTION

1.3.1 Unless identified otherwise, each Trade Contractor shall provide the temporary heat and protection necessary to allow his work to continue during cold weather. The building shall be considered to be enclosed when the exterior walls, roofing and temporary closures to all wall and roof openings are in place.

1.4 TEMPORARY TELEPHONE SERVICE

1.4.1 Each Trade Contractor shall provide temporary job site telephone service as required at his own expense.

1.4.2 Telephone numbers for summoning aid, such as the Police Department, the Fire Department, physicians, ambulances, and rescue squads from outside sources shall be conspicuously posted by the Construction Manager at the site of the work.

1.5 TEMPORARY POTABLE WATER SUPPLY

1.5.1 Unless identified otherwise, the Mechanical Trade Contractor (WC 27) shall furnish, install, maintain, and remove if necessary, a temporary water supply system as required. Refer to Section 00210 to verify if Owner shall pay for water usage fees when connected to the Owner's existing system.

1.6 TEMPORARY TOILET FACILITIES

1.6.1 The Construction Manager shall provide and maintain adequate toilet facilities in a clean and sanitary condition for the use of all Trade Contractors. The use of chemical toilet facilities will be permitted.

1.7 FIRST AID

1.7.1 The Trade Contractor shall provide a completely equipped first-aid kit, which shall be readily accessible at all times and shall be provided and maintained at the site of the work in a clean and orderly condition. The required number of employees who have been properly instructed shall be designated to be in charge of first aid work. At least one such employee shall be available at all times that the work is in progress.

1.8 TEMPORARY FIRE PROTECTION

1.8.1 Each Trade Contractor shall be responsible for temporary fire protection related to his own work.

1.8.2 Unless identified otherwise, The General Trades Contractor (WC 20) shall furnish fire extinguishers in accordance with OSHA, as required for the building. Each Trade Contractor shall furnish fire extinguishers in accordance with OSHA requirements when his work required additional extinguishers.

01520 CONSTRUCTION AIDS

1.1 HOISTING & SCAFFOLDING

1.1.1 All hoisting required in the performance of each Trade Contractor will be provided by that Contractor. If a crane is 125 tons or greater, or is a tower crane, only certified operators are allowed. Trade Contractor is responsible for providing required documentation of certification of operators PRIOR to start of work.

1.1.2 Each Trade Contractor shall provide his own scaffolding, which shall be in accordance with all OSHA safety requirements.

01530 BARRIERS

1.1 TEMPORARY SITE FENCE

1.1.1 The temporary site fencing will be provided by the Construction Manager unless otherwise specifically noted.

1.2 TEMPORARY BARRICADES, TRAFFIC CONTROL & TRAFFIC LIGHTS

1.2.1 Each Trade Contractor is responsible for the maintenance and replacement (when removed) of all temporary barricades, traffic control, and traffic lights. In addition, each Trade Contractor shall be responsible for installation of temporary barricades in accordance with MIOSHA requirements at openings created by that trade contractor.

01540 SECURITY

1.1 WATCHMAN

1.1.1 Unless identified otherwise, the services of a watchman will not be provided by either the Owner or the Construction Manager. Each Trade Contractor shall be responsible for,

and make good any loss not covered by the Builder's Risk Insurance and shall be responsible for the associated deductible costs.

01550 ACCESS ROADS & PARKING AREAS

1.1 CONSTRUCTION PARKING

1.1.1 Refer to Section 00210 for parking requirements.

01560 SPECIAL CONTROLS

1.1 WORK INCLUDED: The work covered by this Section of the Specifications pertains to Special Controls.

1.1.1 LIMITING EXPOSURES OF WORK: Each Trade Contractor shall supervise performance of the work in such a manner and by such means which will ensure that none of the work, whether completed or in progress, will be subjected to harmful, dangerous, damaging or otherwise deleterious exposure during the construction period. Such exposures include, where applicable, but not by way of limitation the following:

- Excessive static or dynamic loading.
- Excessive internal or external pressures.
- Excessively high or low temperatures.
- Thermal shock.
- Excessively high or low humidity.
- Air contamination or pollution.
- Water or ice.
- Solvents.
- Chemicals.
- Light.
- Puncture.
- Abrasion.
- Heavy traffic.
- Soiling.
- Bacteria.
- Insect infestation.
- Combustion.
- Electrical current.
- High speed operation, improper lubrication, unusual wear or other misuse.
- Incompatible interface.
- Destructive testing.
- Misalignment.
- Excessive weathering.
- Unprotected storage.
- Improper shipping or handling.
- Theft and Vandalism.

1.2 SPECIAL CONTROLS DESCRIPTIONS

1.2.1 SPECIFICATIONS BY REFERENCE: Where reference is made in the specifications to

standards of any technical society, association, governmental agency, etc., said specifications or standards shall apply and be binding as though fully repeated therein and are to be considered as a part of these specifications.

1.2.2 RELATED WORK: The contractor shall conduct his work in a manner to prevent air, water, and noise pollution by establishing adequate controls during the construction operations. All controls shall be in accordance with the applicable laws of the State of Michigan.

A. AIR POLLUTION: The open burning of combustible wastes from clearing and grubbing operations and of waste construction materials will not be permitted. The Contractor shall dispose of all such wastes at sanitary landfill(s) licensed by the Michigan Department of Natural Resources.

1) Dust Control: The contractor shall maintain all traveled areas in a safe, dust-free condition at all times. To accomplish this, the Contractor shall remove any tracked materials such as mud, dirt, etc. from construction and haul roads, furnish and apply chloride treatment to temporary roads, furnish and install temporary road patches or surfaces, or any approved methods or systems.

B. WATER POLLUTION: The contractor will be required to perform all construction operations in a manner that will conform to the requirements of Act 347, Soil Erosion and Sedimentation Control Act. Methods to be used are indicated herein (Items No. 1 thru No. 46) and referenced with numbers and symbols to the plans when special details are designated. The contractor shall also be required to perform all work in conformance with the requirements of Act 346, Inland Lakes and Streams. The permits for the construction will be obtained by the Owner, unless otherwise noted in the work category description.

C. NOISE POLLUTION: The contractor shall exercise judgment in the conduct of operations, which by nature result in excessive noise. All such operations shall be coordinated with the Construction Manager and Owner to avoid disruption to Owner operations.

D. CONSTRUCTION DEBRIS: All construction debris shall be removed from the construction site(s) at regular intervals and disposed of at sanitary landfill(s) licensed by State department having authority.

E. HOUSEKEEPING: The project work areas shall be maintained in a neat and clean condition and all debris and waste materials shall be removed from work areas on a daily basis.

1.2.3 VEHICULAR AND PEDESTRIAN TRAFFIC CONTROL: The contractor shall be responsible for providing, installing, and maintaining vehicular and pedestrian traffic control signs, lights, and barricades in conjunction with construction operations where applicable. Vehicular traffic control measures shall be in accordance with the Michigan Manual of Uniform Traffic Control Devices.

A. STREET CLOSING: No street or roadway may be closed to traffic without prior written permission of the governing body having jurisdiction over the street or roadway.

B. EXISTING TRAFFIC CONTROL SIGNS: Existing traffic control signs which conflict with construction operations may be temporarily removed. The contractor shall provide traffic control for the duration of the sign displacement and signs shall be replaced in the proper location immediately after construction operations adjacent to the sign locations are completed.

01590 FIELD OFFICES

1.1 The Construction Manager shall maintain a temporary field office at the site, equipped with telephone, plan desk and plan files, properly heated and illuminated for his, the Architect's, and the Owner's exclusive use. Each Trade Contractor shall provide his own office as necessary. Temporary offices shall be arranged to avoid interfering with construction, and location shall be approved by the Construction Manager.

01595 SMOKING POLICY

1.1 Refer to Section 00210 for Smoking Policy. Failure to comply with this policy may result in the loss of smoking privileges for all construction personnel on the project, and/or dismissal from the site. There will be no smoking in the Construction Manager's field office.

END OF SECTION

01600 MATERIAL AND EQUIPMENT

01610 MOVING MATERIALS

1.1 If at any time it becomes necessary to move materials temporarily located on site, which is to enter into their final construction, the Trade Contractor furnishing the materials shall, when so directed by the Construction Manager, move them to another location at his own expense.

01620 STORAGE & PROTECTION

1.1 GENERAL

1.1.1 Each Trade Contractor shall use the area designated by the Construction Manager for storage of materials, etc., but shall confine this area to a minimum within Contract limits as shown on the plans. Storage beyond this area will not be permitted. Roof areas shall NOT be used for the storage of windows, removals, debris or any other construction items. Storage on the site is very limited and Trade Contractors shall provide for the bulk of materials remote from the site. Refer to Section 00210 for project specific requirements.

1.1.2 Each Trade Contractor shall provide suitable and sufficiently enclosed and covered spaces, with raised flooring, to protect materials and equipment from damage by weather or construction work.

01625 SALVAGING OF MATERIALS

1.1 GENERAL

1.1.1 If applicable, materials or equipment shown on drawing or specified herein to be salvaged but not reused, shall become the property of the Owner and each Trade Contractor shall deliver said items to location designated by the Construction Manager. All items not specified to be salvaged for reuse or delivered to the Owner, will be removed from the project site and disposed of legally.

01631 PRODUCTS AND SUBSTITUTIONS

1.1 SUMMARY

Specified Herein: General Requirements for Substitutions and Product Acceptance.

1.2 SUBSTITUTION SUBMITTALS

1.2.1 The following submittals shall be required for materials, assemblies, and component parts of assemblies where scheduled in the "Submittals" Section of Division 1, specified in the Trade Sections or required by the Construction Manager or the Architect as a condition

precedent to acceptance of a proposal material, a statement of:

a. Product Certification
b. Manufacturer's review of documents and conditions of use.
c. Approval of proposed Applicator or Installer.
d. Proposal for on-site instruction.
e. Manufacturer's supervision of inspection.

1.2.2 Submittals shall be in same form as specified for Request for Acceptance of Materials described herein and, wherever practical should accompany such request.

1.2.3 Submit description of the complete system for each assembly listing all proposed components and acknowledging adjacent materials which are in contact with material or function as a part of the system.

1.2.4 Where one or more of these services are specified, they are considered to be an integral part of the new system. A proposal to delete any specified service will be considered as a reduction in Scope, subject to general conditions for changes in the work.

1.3 MODIFICATIONS

1.3.1 Letter of certification, or request for acceptance, shall indicate all modifications and clarifications to the Contract Documents, including additional instructions for installation or use, which are, in the opinion of the Manufacturer, necessary for proper performance.

1.3.2 If any of the services specified under this Section are not scheduled as a requirement but are normally recommended by the Manufacturer, notify the Construction Manager and the Architect of such recommendation.

1.3.3 Modifications and clarifications to the Contract Documents, which in the opinion of the Architect do not affect the finished quality of appearance of the Work, will be accepted, subject to the following conditions:

a. Conform to the functional intent of system design.
b. Accepted by all contracting parties, including Subcontractor and Manufacturer.
c. Include all costs in the original bid price for adjustments to the scope of the Work including the work of other trades.

1.3.4 Modification which affect the scope of the work, or the work of other trades, and for any reason can not be settled prior to bidding, will be considered under the terms of the General Conditions as Changes in the Work.

1.4 PROTECTION CERTIFICATION

1.4.1 Product certification is a statement by the manufacturer that to the best of its knowledge, the material has not failed to perform when previously used for similar purposes and under similar conditions of use.

1.4.2 Obtain and submit statements from manufacturers and fabricators of materials, assemblies

and component parts of assemblies that the product as delivered conforms to their published data.

1.4.3 Obtain manufacturer's approval for all variations from published recommendations for installation, operation and conditions of use.

1.4.4 It shall be the duty of the supplier of any material on this Work to submit evidence, upon request, that his material is in compliance with the applicable codes, ordinances and standards referenced therein, in the method in which the material is used in this project.

1.5 GENERAL REQUIREMENTS FOR SUBSTITUTIONS

1.5.1 The Contract Documents indicate and call for certain articles, devices, products, fixtures, materials and work by named manufacturers. The Contract shall be based on materials and work manufactured and supplied by those named.

1.5.2 Definitions:

a. Specified Manufacturers or Materials: Those named in the Contract Documents.
b. Substitutions: Manufacturers or materials, which are not named in the Contract Documents.

1.5.3 Trade Contractor's Responsibility: Manufacturers and trade names are specified to establish a standard. The fact that a product is named does not constitute a guarantee by the Architect that the named Manufacturers have agreed to provide or to modify their product in order to meet all requirements of the Contract Documents. It is the responsibility of the Trade Contractor to obtain assurances from its suppliers that the product it proposes to use will meet all requirements of the Contract Documents. The fact that a material or Manufacturer is a substitution shall not act to either increase or decrease the Trade Contractor's responsibility for performance.

1.5.4 Substitutions During Bidding:

a. Substitutions shall be included in the proposal under the following conditions only and shall follow all requirements of "Acceptance of Substitutions". Paragraph 1.5.6.
b. When the Trade Contractor knows of another product of equal or better quality and performance, which is more readily available.
c. When the trade contractor has had unsatisfactory experience with one or more of the specified products or has reason to believe that the specified manufacturer will not provide the necessary guarantees or assume responsibility for performance.

1.5.5 Substitutions After Contract:

a. Substitutions proposed after execution of the Contract will, if approved by the Architect, be handled in accordance with Article 12 "Changes in the Work" as modified and supplemented herein. A **Request for Change** is sufficient authorization for the Trade Contractor's issuance of a purchase order.

b. A change of Manufacturer or product previously approved will be considered and handled as a Change in the Work.

c. Increases in the cost of materials or Work resulting from the failure of the Trade Contractor to issue a purchase order within the time limits stated in the specified manufacturer's original proposal shall be the sole responsibility of the Trade Contractor and shall not be grounds for a substitution or an increase in the Contract Sum.

1.5.6 Acceptance of Substitutions:

a. Substitutions will be considered for any manufacturer except where only one manufacturer is listed.

b. In all cases where substitutions are proposed by the trade contractor, it shall be the sole responsibility of the trade contractor to provide adequate data and samples as required by the Architect to evaluate the substitution.

c. Request for acceptance of substitution shall be presented not less than seven (7) days in advance of the date on which a decision by the Architect is required and shall:

1) Include all information required by this Specification.
2) State the reason for the substitution.
3) Include accurate cost data if the substitute material involves a change in the Contract Sum, or if so requested by the Architect.
4) Provide or make arrangements for the Manufacturer to provide complete data describing the proposed substitution, including samples and itemized comparison with the specified materials, and work, if requested by the Architect.

d. The Architect shall not be obliged to justify his reason for rejecting a proposed substitution.

e. In the event that a substitution is accepted conditionally on the Contractor's agreement to assume full responsibility for equality and performance, the Contract shall provide a full value warranty and agree to make good all damages resulting from the failure of the substitute product.

1.6 ACCEPTANCE OF MATERIALS AND MANUFACTURERS

1.6.1 Standard Materials:

a. Architect's acceptance applies to the Manufacturer only and shall not act to permit any deviation from other requirements of the Specifications.

b. Acceptance will be based on the Manufacturer's specifications at time of issuance of Bidding Documents. Deviations from such specifications shall be considered as a substitution.

c. Requests for acceptance shall be in tabular form stating Specification paragraph and material selected, except as otherwise provided.

d. Shop Drawings shall not indicate any material for which acceptance has not been received, unless accompanied by a separate request for approval. In no case shall Architect's review and return of Shop Drawings constitute and acceptance of either specified or substitute manufacturers or materials.

1.6.2 Special Materials

a. Special materials are materials, which are specified as requiring supervision or technical services by the manufacturer for proper installation.

b. Request for acceptance of special materials shall include a letter from the manufacturer which letter shall contain all information required hereinafter.

1.6.3 Materials Involving Supplementary Warranty or Maintenance Contract:

a. These materials shall be submitted as a request for acceptance over the signature of a qualified technical representative in the direct employment of the manufacturer or such other person as the manufacturer may authorize in writing. Request for acceptance shall contain the following information:

1) Name of project.
2) Name of Contractor, Subcontractor or other party to whom material is furnished.
3) Reference to Specification Section and Article where material is specified and other Contract Documents necessary for identification.
4) Statement of acceptance of documents, conditions, and performance requirements.
   i. Statement that documents as issued are in accordance with manufacturer's recommendations for use of specified materials, or
   ii. Recommended modification of detail, use, application or for substitution of different product by same manufacturer as being more suitable for the performance requirements of the warranty.
5) Statement that detailed installation instructions will be provided.
6) Extent of job site technical services, consultants or instructors proposed, if any.
7) Statement that warranty will be provided.
8) Special provisions required to keep warranty in force.

b. Requests for acceptance may be in the form of a letter including the above items and addressed to the subcontractor responsible for installation of the material, or may be according to a sample form of Material Proposal, provided by the Architect.

c. Upon receipt of the manufacturer's proposal, the subcontractor shall add his own statement agreeing to comply with the manufacturer's requirements and warranting his own workmanship.

d. The contractor shall submit letter of endorsement and copies of all documents, including letters of comment, to the Architect for approval. In the event that the

request for approval recommends a change in the work, modification of detail, or substitution of material, the contractor shall indicate his concurrence with the change as being within the scope of the contract or indicate the change in the Contract Sum for making such change, or state his objections to the change.

1.7 AIR POLLUTION CONTROL

1.7.1 Request for approval of equipment, which may generate air pollutants, shall be accompanied by certification of compliance with approvals from all State and Local Air Pollution Control Authorities having jurisdiction.

1.7.2 Request shall state that manufacturer has provided all information and complied with all requirements of the above agencies including requirements for in place monitoring and measurements.

1.8 INSPECTION AND TESTING

1.8.1 In accordance with Sections of this Division applying to Laboratory Tests and Inspections, the Owner has the option to employ independent inspectors for certain portions of the Work and to have materials tested by an Independent Testing Laboratory.

1.8.2 In addition to necessary samples of materials, manufacturer shall provide information and data required by the laboratories and inspectors for the proper performance of their work.

1.8.3 Where certification by Independent Testing Laboratory is required to demonstrate compliance with a specified standard (ASTM, ANSI or similar), Laboratory Reports shall be dated not more than two years prior to submittal and shall refer to the issue of said standard current as of the issue date of the Contract Documents. Later issue or similar standards superseding the standards will be accepted subject approval by the Architect.

END OF SECTION

1700 PROJECT CLOSEOUT

1.1 DESCRIPTION OF REQUIREMENTS

1.1.1 DEFINITIONS: Project closeout is the term used to describe certain collective project requirements, indicating completion of the Work that are to be fulfilled near the end of the Contract time in preparations for final acceptance and occupancy of the Work by the Owner, as well as final payment to each Trade Contractor and the normal termination of the Contract.

a. Specific requirements for individual units of work are included in the appropriate sections in Divisions 2 through 42.

1.2 PREREQUISITES FOR SUBSTANTIAL COMPLETION

1.2.1 GENERAL: Complete the following before requesting the Construction Manager to coordinate inspections for certification of substantial completion, either for the entire Work or for portions of the Work. List known exceptions in the request.

a. In the progress payment request that coincides with, the date substantial completion is claimed, show either 100% completion for the portion of the Work claimed as "substantially complete", or list incomplete items, the value of incomplete work, and reasons for the Work being incomplete.
b. Include supporting documentation for completion as indicated in these contract documents.
c. Advise Construction Manager of pending insurance change-over requirements.
d. Submit special warranties, workmanship/maintenance bonds, maintenance agreements, final certifications, and similar documents.
e. Obtain and submit releases enabling the Owner's full, unrestricted use of the Work and access to services and utilities. Where required, include occupancy permits, operating certificates and similar releases.
f. Submit record drawings, maintenance manuals, final project photographs, damage or settlement survey, property survey, and similar final record information.
g. Deliver tools, spare parts, extra stocks of material and similar physical items to Construction Manager.
h. Make the final change-over of locks and transmit keys to the Construction Manager. Advise the Construction Manager's personnel of the change over in security provisions.
i. Complete start up testing of systems, and instruction of the Owner's operating and maintenance personnel. Discontinue or change over and remove temporary facilities and services from the project site, along with construction tools and facilities, mockups, and similar elements.
j. Complete final cleaning up requirements, including touch-up painting of marred surfaces.
k. Touch-up and otherwise repair and restore marred exposed finishes.
l. Submit a statement showing an accounting of change-over requirements.

1.2.2 INSPECTION PROCEDURES: Upon receipt of the Trade Contractor's request for inspection, the Architect/Engineer will either proceed with inspection or advise the Construction Manager of unfilled prerequisites.

a. Following the initial inspection, the Architect/Engineer will either prepare the certificate of substantial completion, or will advise the Construction Manager of work which must be performed before the certificate will be issued. The Architect/Engineer will repeat the inspection when requested and when assured

that the Work has been substantially completed.

b. Results of the completed inspection will form the initial "punchlist" for final acceptance.

1.3 PREREQUISITES FOR FINAL ACCEPTANCE

1.3.1 GENERAL: Complete the following before requesting the Architect / Engineer's final inspection for certification of final acceptance, and final payment as required by the General Conditions. List known exceptions, if any, in the request.

a. Submit the final payment request with final releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.
b. Submit an updated final statement, accounting for final additional changes to the Contract Sum.
c. Submit a certified copy of the Architect/Engineer's final punchlist of itemized work to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance and has been endorsed and dated by the Architect/Engineer.
d. Submit consent of surety.
e. Submit a final liquidated damages settlement statement, acceptable to the Owner where applicable.
f. Submit evidence of final, continuing insurance coverage complying with insurance requirements.

1.3.2 REINSPECTION PROCEDURE: The Architect/Engineer will reinspect the Work upon receipt of the Construction Manager's notice that the work, including punchlist items resulting from earlier inspections, has been completed, except for these items whose completion has been delayed because of circumstances that are acceptable to the Architect/Engineer.

a. Upon completion of reinspection, the Architect/Engineer will either prepare a certificate of final acceptance, or will advise the Construction Manager of work that is incomplete or of obligations that have not been fulfilled, but are required for final acceptance.
b. If necessary, the reinspection procedure will be repeated.

1.4 RECORD DOCUMENT SUBMITTALS

1.4.1 GENERAL: Specific requirements for record documents are indicated in the individual sections of these specifications. Other requirements are indicated in the General Conditions. General submittal requirements are indicated in the various "submittals" sections.

a. Do not use record documents for construction purposes; protect from deterioration and loss provide access to record documents for the Architect/Engineer's reference during normal working hours.

1.4.2 Record Drawings: Maintain a record set contract drawings and shop drawings in a clean, undamaged condition. Mark up the set of record documents to show the actual installation where the installed work varies substantially from the work as originally shown. Mark whichever drawing is most capable of showing the actual "field" condition fully and accurately; however, where shop drawings are used for mark up, record a cross reference at the corresponding location on the working drawings. Give particular

attention to concealed work that would be difficult to measure and record at a later date.

a. Mark record sets with red erasable pencil and, where feasible, use other colors to distinguish between variations in separate categories of work.
b. Mark up new information, which is known to be important to the Owner, but for some reason was not shown on either contract drawings or shop drawings.
c. Note related change order numbers where applicable.
d. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.
e. At the completion of the Trade Contractor's work, submit record sets of drawings to the Construction Manager showing all record drawing conditions.

1.4.3 RECORD SPECIFICATIONS: Maintain one complete copy of the Project Manual, including specifications addenda, bulletins, and one copy of other written constriction documents such as change orders and similar modifications issued in printed form during construction. Mark these documents to show substantial variations in the actual work performed in comparison with the text of the specifications and modifications as issued. Give particular attention to substitutions, selection of options and similar information on work where it is concealed or cannot otherwise be readily discerned at a later date by direct observation. Note related record drawing information and product data, where applicable.

a. Upon completion of the Work, submit record specifications to the Construction Manager for the Owner's records.

1.4.4 RECORD PRODUCT DATA: Maintain one copy of each product data submittal. Mark these documents to show significant variations in the actual Work performed in comparison with the submitted information. Give particular attention to concealed products and portions of the Work, which cannot otherwise be readily discerned at a later date by direct observation. Note related change orders and markup of record drawings and specifications.

a. Upon completion of mark up, submit complete sets of record product data to the Construction Manager for the Owner's records.

1.4.5 MISCELLANEOUS RECORD SUBMITTALS: Refer to other sections of the specifications for requirements of miscellaneous record keeping and submittals in connection with the actual performance of the Work. Immediately prior to the date or dates of substantial completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for continued use and reference. Submit to Construction Manager for the Owner's records.

1.4.6 MISCELLANEOUS MANUALS; Organize operating and maintenance date into suitable sets of manageable size. Bind data into individual binders properly identified and indexed. Unless identified otherwise, bind each set of data in a heavy duty 3 ring vinyl covered binder, with pocket folders for folded sheet information. Mark the appropriate identification on both front and spine of each binder. 3-ring vinyl covered binder, with pocket folders for folded sheet information. Mark the appropriate identification on both front and spine of each binder.

a. Include the following types of information in operation and maintenance manuals:
   - Emergency instructions.
   - Spare parts listing.
   - Copies of warranties.

- Wiring diagrams.
- Recommended "turn around" cycles.
- Inspection procedures.
- Shop drawings and product data.

2.1 EXECUTION

2.2 CLOSEOUT PROCEDURES

2.2.1 GENERAL OPERATING AND MAINTENANCE INSTRUCTIONS: Arrange for each installer of operating equipment and other work that requires regular or continuing maintenance, to meet at the site with the Owner's personnel to provide necessary basic instruction in the proper operation and maintenance of the entire Work. Where installers are not experienced in the required procedures, include instruction by the manufacturer's representatives.

a. As part of this instruction provide a detailed review of the following items:
   - Maintenance manuals.
   - Record documents.
   - Spare parts and materials.
   - Tools.
   - Lubricants.
   - Fuels.
   - Identification systems.
   - Control sequences.
   - Hazards.
   - Cleaning.
   - Warranties, bonds, maintenance agreements and similar continuing commitments.

b. As part of this instruction for operating equipment demonstrate the following procedures:
   - Start-up.
   - Shut down.
   - Noise and vibration adjustments.

2.3 FINAL CLEANING

2.3.1 GENERAL: Special cleaning requirements for specific units of Work are included in the appropriate sections of the specifications. General Cleaning during the regular progress of the Work is required by the General Conditions and Subcontract Agreements.

2.3.2 CLEANING: Provide final cleaning of the Work at the time indicated. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit of work to the condition expected from a normal, commercial building cleaning and maintenance program. Comply with the manufacturer's instructions for operations.

Complete the following cleaning operations before requesting the Architect /Engineer's inspection for certification of substantial completion:

a. Remove labels which are not required as permanent labels.
b. Clean transparent materials, including mirrors and glass in doors and windows, to a polished condition. Remove substances, which are noticeable as vision obscuring materials. Replace chipped or broken glass and other damaged transparent materials.

c. Clean exposed exterior and interior hard surfaced finishes to a dust free condition, free of dust, stains, films and similar noticeable distracting substances. Leave concrete floors broom clean. Vacuum carpeted surfaces.

d. Wipe surfaces of mechanical and electrical equipment clean. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.

e. Clean the project site, including landscape development areas, of rubbish, litter and other foreign substances. Sweep paved areas to a broom clean condition; remove stains, spills and other foreign deposits. Rake grounds that are neither paved nor planted, to a smooth even textured surface.

2.3.3 REMOVAL OF PROTECTION: Remove temporary protection devices and facilities, which were installed during the course of the work to protect previously, completed work during remainder of the construction period.

2.3.4 COMPLIANCE: Comply with safety standards and governing regulations for cleaning operation. Do not burn waste materials at site. Do not bury debris or excess materials on Owner's property. Do not discharge volatile or other harmful or dangerous materials into drainage systems. Remove waste materials from the site and dispose of in a lawful manner.

a. Where extra materials of value remaining after completion of associated work have become Owner's property, dispose of these materials to the Owner's best advantage as directed.

END OF SECTION

01740 WARRANTIES

PART 1 - GENERAL

1.1 SUMMARY

1.1.1 Specified Herein: Warranties and continuing services required to be provided by manufacturers of materials and systems where required for proper performance.

1.1.2 The word "Guarantee" when appearing in any Contract Document or construction correspondence shall be defined as warranty in accordance with Article 3.5 of the General Conditions.

1.2 SUBMITTALS

1.2.1 Submit warranties in accordance with Article 3.5 of the General Conditions as modified by Supplementary Conditions and additional requirements specified under the individual Trade Sections.

1.2.2 Required types of warranties and additional services are scheduled and listed in the Trade Sections.

1.2.3 In all cases where "Special Warranties" or "Service Contracts" are required, the request for approval of materials will be accepted by the Owner and the Architect on the understanding that manufacturer agrees to provide the specified warranty or other service unless stated otherwise in the request.

1.2.4 The Owner will not be bound to accept any limitations or variations from the specified warranty, which were not filed with the request for acceptance and accepted prior to purchase of materials.

1.2.5 Warranties shall be submitted prior to request for payment for 100% completion in each case, shall acknowledge the responsibilities defined under Supplementary Conditions and shall include:

a. Manufacturer's warranty that all materials comply with its published standards, comply with the requirements of the Specifications and where specified, are adequate for the proposed use.
b. Subcontractor's warranty that all workmanship complies with the requirements of the Specifications and of the manufacturer.
c. Contractor's warranty covering the entire work and accepting responsibility for all limitations imposed by the manufacturer or subcontractor except where such limitations have been previously accepted by the Architect.
d. Certification and verification of previously submitted information including statement of all limitations, required maintenance and similar conditions of the warranty.

1.3 STANDARD WARRANTIES

1.3.1 A standard warranty is a warranty whose terms are essentially the same as normally offered by the manufacturer of standard with the industry.

1.3.2 General Conditions require that standard warranties apply as a minimum requirement notwithstanding the fact that submittal of a copy of the warranty is not required.

1.3.3 Unless otherwise specified, a standard warranty shall be for a period on one (1) year from Date of Substantial Completion.

1.3.4 Contractor shall obtain and furnish to the Owner from each manufacturer of materials or equipment incorporated into the Work a warranty at least as favorable to Owner as that customarily given by such manufacturer to others. Contractor shall inform itself as to any conditions precedent to the effectiveness of each manufacturer's warranty and comply with all such conditions (or obtain waivers thereof from the manufacturer) so that such warranty shall be fully effective. If any event occurs which might invalidate any manufacturer's warranty, contractor shall promptly notify the Owner and the Architect.

1.3.5 All warranty periods shall commence on the Date of Substantial Completion except that, if it is discovered after said date that certain work or materials were not in fact in conformance with the requirements of the Contract Documents, the applicable warranty period shall re-commence from the completion of the repair or replacement of such Work to make it so conform.

1.3.6 The fact that a manufacturer's warranty differs in its terms from those of the contractor or any subcontractor, the acceptance by the Owner of any warranty of a manufacturer or subcontractor, or the fact that the Owner has claimed initially on such warranty, shall not in any way release contractor from his warranty obligations under the contract.

1.4 SPECIAL WARRANTIES

1.4.1 A special warranty is one whose terms, in addition to the standard coverage offered by the manufacturer, contain other special provisions, including:

a. Acknowledgment of specified list of items, which shall be specifically noted as being covered by the warranty.
b. Acknowledgment of specific conditions for use or exposure.
c. Extension of warranty to waive standard exceptions or to extend limits including time.
d. Requirements for specific performance by other trades including method of separation and protection from, or assurance of compatibility with, adjacent materials.
e. Assemblies and systems, which may include products of other manufacturers.
f. Conditions where certain performance criteria are specified and must be either acknowledged or actual limits are required to be determined by performance testing subject to Owner's review and acceptance.
g. Conditions where manufacturer's continuing involvement such as maintenance or advisory service is required.

1.4.2 Maintenance Service During Warranty Period:

a. Reference to routine maintenance required to be performed by the Owner during the warranty period shall be listed in the original submittal of proposed warranty.

b. All other administration and maintenance service required during the warranty period, including installation of items repaired or replaced under the terms of the warranty shall be included in the original Contract.

1.5 SERVICE CONTRACTS

1.5.1 Required types of Service Contract Proposals are scheduled under Schedule or Required Submittals and are listed in the Trade Sections.

1.5.2 Where specified, the subcontractor or manufacturer originally supplying services and skills required for proper maintenance and agreeing to maintain availability of replacement parts and materials.

1.5.3 The Service Contract is in addition to, and independent of, the Warranty and shall not act to either extend the Warranty or to reduce the contractor's responsibilities thereunder.

1.5.4 Unless otherwise specified or agreed, Service Contracts shall be written for a period of five (5) years starting with the termination of similar services included under the warranty and shall include cancellation privilege annually when exercised at least 60 days prior to anniversary date.

1.5.5 The contractor shall:

a. Prior to submittal of manufacturer of subcontractor for approval, verify that specified service is available and will be offered.
b. Secure from the manufacturer of subcontractor a bona fide proposal to perform the specified services.
c. When so directed, assist the Architect in obtaining proposals for the performance of the specified services by other competent parties.

1.6 ADVISORY AND INSPECTION SERVICE

1.6.1 Advisory and Inspection Service consists of:

a. Periodic inspection on a regular scheduled basis. Include schedule of proposed inspections of the agreement.

b. All necessary information, including special training, where required to adequately instruct Owner's maintenance personnel in preventive maintenance repairs and treatments. If such maintenance work is recommended:

1) Obtain or submit price quotations for recommended work.

2) When so instructed by the Owner, make all necessary arrangements for

the performance of the Work.

1.6.2 Parts and Materials Agreement:

a. Where standard commercially available parts of materials are suitable for maintenance or repair, inform Owner concerning trade name or description and location where they may be obtained.

b. Where parts or materials are not readily available maintain replacement stocks at a location as required to prevent undue delay in repairs or loss of use of equipment pending delivery.

1.7 MAINTENANCE SERVICE

1.7.1 A Maintenance Service Contract is an agreement that in addition to Advisory and Inspection Service, the Manufacturer will provide, or otherwise make available through his agent, a regular maintenance service program scheduled during normal working hours.

1.7.2 Proposals shall schedule proposed times for servicing and list the services to be performed.

1.7.3 Maintenance service of equipment shall be performed solely by the original Equipment Contractor and shall not be assigned or transferred to any agent or subcontractor without the approval of the Owner.

1.7.4 Repairs:

a. Permanent repairs shall be started within seven (7) days after notification by the Owner.

b. In the event that emergency and permanent repairs are not started within the specified time limits, or if the work is stopped without the Owner's consent, the Owner shall have the same options to have repairs performed by others as specified under Warranties without invalidating this agreement.

1.7.5 Equipment maintenance shall include systematic examinations, and adjustments and lubrication of all equipment. The Equipment Maintenance Contractor shall repair and replace electrical and mechanical parts whenever required using only genuine standard parts recommended or produced by the manufacturer of the equipment.

1.7.6 Addition work when so directed by the Owner shall be included under the work of the Maintenance Contract and the Contractor shall be reimbursed at the current prevailing rate for the cost of materials, labor and services. Such additional work shall include:

a. Repairs or replacement required as a result of negligence, abuse, or other actions contrary to the Equipment Contractor's operating instructions.
b. Improvement or additional equipment required by the Owner, Insurance Companies, or Governmental Authorities.

c. Except for emergency service, the additional cost for overtime work based on the difference between regular and overtime labor when the Owner requests that such work be performed outside of regular working and so authorized in writing.

1.7.7 Additional requirements for specific maintenance contracts are specified in the various Trade Sections.

1.8 EMERGENCY CALL-BACK SERVICE

1.8.1 Emergency Call-Back Service is an agreement to provide rescue and repair service on an emergency basis where required for the protection of life and property.

1.8.2 Owner's agreement to permit manufacturers to assign agreement to an agent does not relieve manufacturer of responsibility to verify that service remains available for the specified time.

1.8.3 Agreement shall remain in effect for the lifetime of all Warranties, Service Contracts and for such longer time as may be specified or agreed.

1.8.4 Service shall be available on a 24 hour, 7-day basis and shall be performed within the following time limit after notification of emergency unless otherwise specified. Maintain emergency telephone number on file with the Owner for nights and weekends.

1.9 CERTIFICATION

1.9.1 Product Certification: See Division 1, Section titled "Material and Equipment".

1.9.2 Workmanship Certification is a statement by the applicator or installer that all materials and workmanship in connection with the system have been furnished and installed in complete conformance with Contract Documents, and with the manufacturer's specifications and requirements for the particular type of use specified.

1.9.3 A product certification where specified as a requirement shall be in a form similar to the following:

> "We, the (Manufacturing Company), certify that the complete system as detailed and specified can be installed and will perform in accordance with the requirements of the specifications and the ASTM Standards referenced therein for the guarantee period of one year or such longer period as may be negotiated between the Owner and the (Manufacturing Company).
>
> Upon completion of the Project we will inspect the work and certify to the Owner that the system as installed is in accordance with the Manufacturer's requirements or indicated in writing what remedial action is necessary in order that it does so conform."

END OF SECTION

017419 CONSTRUCTION WASTE MANAGEMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. 017419-1 TCC Waste Management Plan

C. 017419-2 TCC LEED Misc Waste Diversion Form

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for the following:

2. Salvaging non-hazardous demolition and construction waste.
2. Recycling non-hazardous demolition and construction waste.
2. Disposing of non-hazardous demolition and construction waste.

B. Related Sections include the following:

2. Division 1 Section "Summary of Multiple Contracts" for coordination of responsibilities for waste management.

2. Division 1 Section "Temporary Facilities and Controls" for environmental-protection measures during construction, and location of waste containers at Project site.

2. Division 02 Section "Structure Demolition" for disposition of waste resulting from demolition of buildings, structures, and site improvements[, and for disposition of hazardous waste].

2. Division 02 Section "Selective Structure Demolition" for disposition of waste resulting from partial demolition of buildings, structures, and site improvements.

2. Division 04 Section "Unit Masonry" for disposal requirements for masonry waste.

2. Division 04 Section "Stone Masonry" for disposal requirements for excess stone and stone waste.

2. Division 31 Section "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

1.3 DEFINITIONS

A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.4 ACTION SUBMITTALS

A. Comply with Section 017419.1 Waste Management Project Specific Plan or submit an equally comprehensive Waste Management Plan.

1.5 INFORMATIONAL SUBMITTALS

A. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.6 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.

B. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

1.1 PLAN IMPLEMENTATION

A. General: Implement waste management plan as approved by Construction Manager. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

2. Comply with Division 1 Section "Temporary Facilities and Controls" for operation, termination, and removal requirements.

B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan.

C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.

2. Distribute waste management plan to everyone concerned within three days of submittal return.
2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

2. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
2. Comply with Division 1 Section "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

1.2 SALVAGING DEMOLITION WASTE

A. Salvaged Items for Reuse in the Work:

2. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
2. Store items in a secure area until installation.
2. Protect items from damage during transport and storage.
2. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.

B. Salvaged Items for Sale and Donation: Not permitted on Project site.

C. Salvaged Items for Owner's Use:

2. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
2. Store items in a secure area until delivery to Owner.
2. Transport items to Owner's storage area designated by Owner.
2. Protect items from damage during transport and storage.

D. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.

E. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.

F. Plumbing Fixtures: Separate by type and size.

G. Lighting Fixtures: Separate lamps by type and protect from breakage.

H. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

1.3 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

2. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

C. Disposal: Transport waste materials off Owner's property and legally dispose of them.

END OF SECTION

SECTION 018119 – INDOOR AIR REQUIREMENTS

PART 1 – GENERAL

1.2. SECTION INCLUDES
- A. Overview of indoor air quality requirements and procedures, including product/material selection.

1.3. DEFINITIONS
- A. Volatile Organic Compounds (VOCs): Organic chemicals that produce vapors readily at room temperature and normal atmospheric pressure (e.g. gasoline, solvents, etc.). VOCs react with sunlight and nitrogen to form ground-level ozone, a chemical that has detrimental effect on human health, agricultural crops, forests, soil, groundwater and ecosystems.
- B. Carpet and Rug Institute (CRI) Green Label: a program established by the national trade association representing the carpet and rug industry to identify carpet products that have been tested by an independent laboratory and have met the criteria for low VOC emissions.

1.4. REFERENCES
- A. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA). IAQ
  - a. Guidelines for Occupied Buildings Under Construction. Second Edition, 2007.
- B. ASHRAE. ANSI/ASHRAE 52.2-1999: Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- C. EPA. EPA Compendium of Methods for the Determination of Air Pollutants in Indoor Air.
- D. State of California. South Coast Air Quality Management District (SCAQMD) Rule 1168. January 2005 (as amended).
- E. State of California. South Coast Air Quality Management District (SCAQMD) Rule 1113. January 2004 (as amended).
- F. Green Seal. Paints (GS-11). January 1997. May 1993.
- G. Green Seal. Anti-Corrosive Paints (GC-03). January 1997.
- H. U.S. Green Building Council. "Indoor Environmental Quality Credit 3: Construction IAQ
  - a. Management Plan and Credit 4: Low-Emitting Materials" Leadership in Energy and Design
  - b. Environmental Design Reference Guide for Green Building Design and Construction, 2009 Edition. USGBC. "Materials & Resources Credit 2: Construction Waste Management". Leadership in Energy and Environmental Design Reference Guide for Green Building Design and Construction, 2009 Edition.
- I. California Department of Health Services Standard Practice for the Treating of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda.

1.5. OBJECTIVES
- A. Meet or exceed the recommended Design Approaches of the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 2nd Edition, 2007, Chapter 3.
- B. Protect construction workers and future building occupants from indoor air quality problems resulting from construction activities and building materials.
- C. Reduce the production and circulation of pollutants during construction.
- D. Protect equipment and absorptive materials stored and installed on-site from moisture, dust

and dirt accumulation during construction.

E. Prepare the building for occupancy following construction and prior to occupancy.

1.6. DESCRIPTION OF WORK

A. The site superintendent (or other person designated by the Contractor) shall be responsible for all aspects of LEED coordination during construction related to indoor air quality management.

B. Reference 018119-1 TCC Indoor Air Quality Management Plan – During Construction for the required Best Management Practices for Contractors and Sub-Contractors.

1.7. LEED START-UP MEETING

A. Prior to mobilization on-site, the Contractor shall hold a start-up meeting with the Architect to review indoor air quality management requirements. This meeting shall include a review of:

1. Indoor air quality management objectives.
2. Indoor air quality management requirements and procedures.
3. Indoor air quality management documentation and submittals.

1.8. LEED COORDINATION MEETING

A. Prior to start of construction, the Contractor (in conjunction with the Architect) shall hold a coordination meeting with the construction team to explain the indoor air quality management requirements to the Sub-Contractors. This meeting shall include a review of:

1. Indoor air quality management objectives.
2. Indoor air quality management requirements and procedures.
3. Indoor air quality management documentation and submittals.

1.9. SUBMITTALS

A. Product VOC Identification

1. Collect supporting documentation (MSDSs, product data sheets, letter from manufacturers, etc.) to document VOC emission rates for all adhesives, sealants, paints and coatings that are applied onsite and fall within the building weather barrier.
2. Submit completed supporting product literature to the Contractor and Or Architect for review at least 14 days prior to ordering.

B. Low Emitting Flooring Systems

1. Collect supporting documentation (letters from manufacturers, product literature, etc.) for all carpet and hard surface flooring products used in the building.
2. Submit completed supporting product literature to the Contractor and Or Architect for review at least 14 days prior to ordering..

C. IAQ Management Inspection Log

1. Contractor / Subcontractor shall keep a completed log. The log shall commence when the building is enclosed and carry through to building turnover.

D. Photo Documentation Checklist

1. Photographs shall be provided as specified in the checklist.
2. Photographs will be taken on **six** different occasions during construction to prove continuous compliance.

2. PART 2 - PRODUCTS

2.1. GENERAL

A. The VOC content limits listed in this section may be amended from time to time by their governing bodies. In the event that the VOC limits listed below are higher than the VOC limits in effect at the date of application for building permit, the VOC limits in effect at the

date of application for building permit shall be used.

B. Reference SECTION 016119 LEED PRODUCT REQUIREMENTS for product Indoor Air Quality / Emission requirements and acceptable levels.

3. PART 3 - EXECUTION

3.1. POLUTANT SOURCE IDENTIFICATION

A. Identify potential sources of indoor air pollutants on the construction site.

B. Any construction activity or material that produces odor and/or dust is considered a source of air pollutants. Pollutant sources include, but are not limited to:

C. Materials that produce detectable odor:

Paints	Coatings	Grouts
Stains	Adhesives	Epoxy Flooring
Sealants	Caulking	Solvents
Pesticides	Fuels	Cleaning Products

D. Materials that create dust:

Concrete Products	Drywall	Wood Products
Acoustical Ceiling Tile	Insulation	Ceramic Tile

E. Equipment that emit products of combustion or create odor and/or dust:

Generators	Compressors	Cutting Tools / Saws
Touché / Welders	Vehicles	Portable Heaters

F. Construction activities that disrupt pollutants:

Demolition	Repair	Renovation

G. Other

Demolition	Repair	Renovation

3.2. MINIMIZE POLLUTANTS

A. Reference 018119-1 TCC Indoor Air Quality Management Plan – During Construction

B. Additional measures include but are not limited for the minimization of pollutants generated inside the building from the sources identified under article 3.1:

1. Smoking shall be prohibited inside the building at all times during construction and within 25 feet of building entrances once enclosed.
2. Fuelling up equipment outside the building.
3. Storing gasoline or solvents outside the building.
4. Restricting outdoor vehicular/equipment traffic and operation where emissions can enter the building.
5. Reducing on-site emissions by using equipment that burns propane/natural gas or is powered by electricity.
6. Exhausting pollutant sources directly outside using temporary or permanent ventilation equipment. Where exhaust is not feasible, locally re-circulate air through a portable air cleaner.
7. Collecting and bagging sawdust from woodworking tools.
8. Covering and/or sealing all indoor sources of odor and dust.
9. Using painting techniques that minimize odor (e.g roller instead of spraying).
10. Using cleaning practices that minimize dust (e.g. vacuum instead of sweeping).
11. Using cleaning products that minimize pollution, fumes, VOC's, etc.
12. Prohibiting the burning of garbage.

3.3. HOUSEKEEPING MEASURES

A. Prevent the accumulation of moisture, dust and dirt in the building from the sources identified under article 3.1 using the following measures:
    1. Frequently cleaning interior surfaces to minimize dust and dirt accumulation.
        a) Note: Localized cleaning should occur immediately after a construction activity is completed and/or at the end of each day. A full building clean-up must be performed at least once a week.
B. Promptly clean all spills (fuels, lubricants, paints, adhesives, etc.).
C. Clean or remove excess products.
    1. All Pollutant Containment, Housekeeping and HVAC protection measures will be reviewed by the Contractor and / or Architect during site visits.
        a) All deficiencies identified by the Contractor and / or Architect must be remedied and documented in the IAQ Management Inspection Log within 48 hours of notification.
        b) The Contractor shall clean or replace any equipment or materials that is incorrectly stored or improperly protected at no extra cost to the contract.

3.4. REMOVAL OF PROTECTION MEASURES

A. All products/materials installed as a part of indoor air quality management measures shall be removed prior to building turnover. Any remedial work required as a result of removing the measures is the responsibility of the Contractor.

END OF SECTION 018119

Project Manual

Lansing School District SB-0051
Averill New Tech Elementary Mechanical Improvements
Ingham County, Michigan

C2AE Project #22-0117

November 11, 2022

106 W. Allegan St. Suite 500
Lansing, MI 48933

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PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Requirements:
   1. Document 002600 "Procurement Substitution Procedures" for requirements for substitution requests prior to award of Contract.
   2. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.2 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
   1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
   2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.3 ACTION SUBMITTALS

A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
   1. Substitution Request Form: Use form provided in Project Manual.
   2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
      a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
      b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
      c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
      d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
      e. Samples, where applicable or requested.
      f. Certificates and qualification data, where applicable or requested.

g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects and owners.
h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
j. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
k. Cost information, including a proposal of change, if any, in the Contract Sum.
l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor through Construction Manager of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
   a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
   b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.4 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.5 PROCEDURES

A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

1.6 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
   1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
      a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
      b. Substitution request is fully documented and properly submitted.
      c. Requested substitution will not adversely affect Contractor's construction schedule.
      d. Requested substitution has received necessary approvals of authorities having jurisdiction.
      e. Requested substitution is compatible with other portions of the Work.
      f. Requested substitution has been coordinated with other portions of the Work.
      g. Requested substitution provides specified warranty.
      h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Not allowed.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

REQUEST FOR SUBSTITUTION

TO: _____ **DATE:** _____

PROJECT: _____

SECTION	**PARAGRAPH**	**SPECIFIED ITEM**
_____	_____	_____

PROPOSED SUBSTITUTION: _____ **MODEL:** _____

MANUFACTURER: _____ **PHONE:** (____) _____

Include product description, specifications, drawings, photographs, performance and test data adequate for evaluation. Clearly identify applicable portions of the data. Also include description of changes to contract documents that would be required as a result of the substitution.

The undersigned states that the following line items, unless modified on attachments, are correct:

A. I have read and fully understand the conditions for substitutions outlined in this specification section.

B. The proposed substitution does not affect dimensions shown on drawings.

C. The undersigned will reimburse architect for any building design changes required due to the substitution, including engineering, detailing, and services associated with re-approval by authorities.

D. I will coordinate installation and make both known and unforeseen changes to other work required for substitution at no additional cost to the owner.

E. The proposed substitution will have no adverse effect on other trades, the construction schedule, or specified warranty requirements.

F. Maintenance and service parts will be locally available for the proposed substitution.

G. The undersigned further states that the function, appearance, and quality of the proposed substitutions are equivalent or superior to the specified item.

SUBMITTED BY: _____

SIGNATURE _____

FIRM _____

ADDRESS _____

_____

TELEPHONE (____) _____

FAX (____) _____

FOR USE BY C2AE

ACCEPTED **ACCEPTED AS NOTED**

NOT ACCEPTED **RECEIVED TOO LATE**

BY _____

DATE _____

REMARKS _____

SECTION 013100 – PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
   1. General coordination procedures.
   2. Coordination drawings.
   3. RFIs.
   4. Digital project management procedures.
   5. Project meetings.

B. Related Requirements:
   1. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
   2. Section 019113 "General Commissioning Requirements" for coordinating the Work with Owner's Commissioning Authority.

1.2 INFORMATIONAL SUBMITTALS

A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
   1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
   2. Number and title of related Specification Section(s) covered by subcontract.
   3. Drawing number and detail references, as appropriate, covered by subcontract.

1.3 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.
   1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
   2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
   3. Make adequate provisions to accommodate items scheduled for later installation.

B. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
   1. Preparation of Contractor's construction schedule.
   2. Preparation of the schedule of values.
   3. Installation and removal of temporary facilities and controls.
   4. Delivery and processing of submittals.
   5. Progress meetings.
   6. Preinstallation conferences.
   7. Project closeout activities.
   8. Startup and adjustment of systems.

1.4 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
   1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
      a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
      b. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:
   1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
   2. Plenum Space: Indicate subframing for support of ceiling, raised access floor, and wall systems, mechanical and electrical equipment, and related Work. Locate components within plenums to accommodate layout of light fixtures and other components indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
   3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
   4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.

5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
6. Review: Architect will review coordination drawings to confirm that, in general, the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make suitable modifications and resubmit.

1.5 REQUEST FOR INFORMATION (RFI)

A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
1. Architect will return without response those RFIs submitted to Architect by other entities controlled by Contractor.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Owner name.
2. Owner's Project number.
3. Name of Architect.
4. Architect's Project number.
5. Date.
6. Name of Contractor.
7. RFI number, numbered sequentially.
8. RFI subject.
9. Specification Section number and title and related paragraphs, as appropriate.
10. Drawing number and detail references, as appropriate.
11. Field dimensions and conditions, as appropriate.
12. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
13. Contractor's signature.
14. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Architect.

D. Architect's and Construction Manager's Action: Architect and Construction Manager will review each RFI, determine action required, and respond. Allow three days for Architect's response for each RFI. RFIs received by Architect or Construction Manager after 1:00 p.m. will be considered as received the following working day.
   1. The following Contractor-generated RFIs will be returned without action:
      a. Requests for approval of submittals.
      b. Requests for approval of substitutions.
      c. Requests for approval of Contractor's means and methods.
      d. Requests for coordination information already indicated in the Contract Documents.
      e. Requests for adjustments in the Contract Time or the Contract Sum.
      f. Requests for interpretation of Architect's actions on submittals.
      g. Incomplete RFIs or inaccurately prepared RFIs.
   2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect or Construction Manager of additional information.
   3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."
      a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect and Construction Manager in writing within five days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log [weekly] <Insert time>. [Use software log that is part of web-based Project management software.] [Include the following:] [Software log with not less than the following:]
   1. Project name.
   2. Name and address of Contractor.
   3. Name and address of Architect and Construction Manager.
   4. RFI number including RFIs that were returned without action or withdrawn.
   5. RFI description.
   6. Date the RFI was submitted.
   7. Date Architect's and Construction Manager's response was received.

F. On receipt of Architect's and Construction Manager's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect and Construction Manager within three days if Contractor disagrees with response.

1.6 DIGITAL PROJECT MANAGEMENT PROCEDURES

A. Architect's Data Files Not Available: Architect will not provide Architect's CAD drawing digital data files for Contractor's use during construction.

B. PDF Document Preparation: Where PDFs are required to be submitted to Architect, prepare 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.
   3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other sections and when required for coordination with other construction.
   1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect, Construction Manager of scheduled meeting dates.
   2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
      a. Contract Documents.
      b. Options.
      c. Related RFIs.
      d. Related Change Orders.
      e. Purchases.
      f. Deliveries.
      g. Submittals.
      h. Sustainable design requirements.
      i. Review of mockups.
      j. Possible conflicts.
      k. Compatibility requirements.
      l. Time schedules.
      m. Weather limitations.
      n. Manufacturer's written instructions.
      o. Warranty requirements.
      p. Compatibility of materials.
      q. Acceptability of substrates.
      r. Temporary facilities and controls.
      s. Space and access limitations.
      t. Regulations of authorities having jurisdiction.
      u. Testing and inspecting requirements.
      v. Installation procedures.
      w. Coordination with other work.
      x. Required performance results.
      y. Protection of adjacent work.
      z. Protection of construction and personnel.
   3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.

4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Submittal schedule requirements.
   2. Administrative and procedural requirements for submittals.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect's and Construction Manager'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 and Construction Manager'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."

1.3 SUBMITTAL SCHEDULE

A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and Construction Manager and additional time for handling and reviewing submittals required by those corrections.

1.4 SUBMITTAL FORMATS

A. Submittal Information: Include the following information in each submittal:
   1. Project name.
   2. Date.
   3. Name of Architect.
   4. Name of Construction Manager.
   5. Name of Contractor.
   6. Name of firm or entity that prepared submittal.
   7. Names of subcontractor, manufacturer, and supplier.
   8. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier; and alphanumeric suffix for resubmittals.
   9. Category and type of submittal.
   10. Submittal purpose and description.
   11. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
   12. Drawing number and detail references, as appropriate.

13. Indication of full or partial submittal.
14. Location(s) where product is to be installed, as appropriate.
15. Other necessary identification.
16. Remarks.
17. Signature of transmitter.

B. Options: Identify options requiring selection by Architect.

C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect and Construction Manager on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.

D. Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

E. Submittals for Utilizing Web-Based Project Management Software: Prepare submittals as PDF files, or other format indicated by Project management software.

1.5 SUBMITTAL PROCEDURES

A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
   1. Email: Prepare submittals as PDF package, and transmit to Architect by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Architect.
   2. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project management software website. Enter required data in web-based software site to fully identify submittal.
   3. Paper: Prepare submittals in paper form, and deliver to Architect.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
   1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
   2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
   3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.

C. 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. Resubmittal Review: Allow 15 days for review of each resubmittal.

D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

F. 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 and Construction Manager's action stamp.

1.6 SUBMITTAL REQUIREMENTS

A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
   1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
   2. Mark each copy of each submittal to show which products and options are applicable.
   3. Include the following information, as applicable:
      a. Manufacturer's catalog cuts.
      b. Manufacturer's product specifications.
      c. Standard color charts.
      d. Statement of compliance with specified referenced standards.
      e. Testing by recognized testing agency.
      f. Application of testing agency labels and seals.
      g. Notation of coordination requirements.
      h. Availability and delivery time information.
   4. For equipment, include the following in addition to the above, as applicable:
      a. Wiring diagrams that show factory-installed wiring.
      b. Printed performance curves.
      c. Operational range diagrams.
      d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
   5. Submit Product Data before Shop Drawings, and before or concurrent with Samples.

B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
   1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
      a. Identification of products.
      b. Schedules.
      c. Compliance with specified standards.
      d. Notation of coordination requirements.
      e. Notation of dimensions established by field measurement.
      f. Relationship and attachment to adjoining construction clearly indicated.
      g. Seal and signature of professional engineer if specified.

C. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.
   1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
   2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
      a. Project name and submittal number.
      b. Generic description of Sample.
      c. Product name and name of manufacturer.
      d. Sample source.
      e. Number and title of applicable Specification Section.
      f. Specification paragraph number and generic name of each item.
   3. Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample characteristics, and identification information for record.
   4. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
   5. Paper Transmittal: Include paper transmittal including complete submittal information indicated.
   6. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
      a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
      b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
   7. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

a. Number of Samples: Submit three sets of Samples. Architect and Construction Manager will retain two Sample sets; remainder will be returned.
   1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
   2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.

G. Certificates:
   1. Certificates and Certifications Submittals: Submit 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. Provide a notarized signature where indicated.
   2. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
   3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
   4. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
   5. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
   6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

H. Test and Research Reports:
   1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for substrate preparation and primers required.
   2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
   3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
   4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
   5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
   6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
      a. Name of evaluation organization.
      b. Date of evaluation.
      c. Time period when report is in effect.
      d. Product and manufacturers' names.
      e. Description of product.
      f. Test procedures and results.
      g. Limitations of use.

1.7 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 insufficient 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 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.

1.8 CONTRACTOR'S REVIEW

A. Action Submittals 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 and Construction Manager.

B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp. Include 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.
   1. Architect will not review submittals received from Contractor that do not have Contractor's review and approval.

1.9 ARCHITECT'S AND CONSTRUCTION MANAGER'S REVIEW

A. Action Submittals: Architect and Construction Manager will review each submittal, indicate corrections or revisions required**, and return it**.
   1. PDF Submittals: Architect and Construction Manager will indicate, via markup on each submittal, the appropriate action.

B. Informational Submittals: Architect and Construction Manager will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Architect will discard submittals received from sources other than Contractor.

F. Submittals not required by the Contract Documents will be returned by Architect without action.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013300

REQUEST FOR SUBSTITUTION

TO: _____ **DATE:** _____

PROJECT: _____

SECTION	**PARAGRAPH**	**SPECIFIED ITEM**
_____	_____	_____

PROPOSED SUBSTITUTION: _____ **MODEL:** _____

MANUFACTURER: _____ **PHONE:** (____) _____

Include product description, specifications, drawings, photographs, performance and test data adequate for evaluation. Clearly identify applicable portions of the data. Also include description of changes to contract documents that would be required as a result of the substitution.

The undersigned states that the following line items, unless modified on attachments, are correct:

A. I have read and fully understand the conditions for substitutions outlined in this specification section.

B. The proposed substitution does not affect dimensions shown on drawings.

C. The undersigned will reimburse architect for any building design changes required due to the substitution, including engineering, detailing, and services associated with re-approval by authorities.

D. I will coordinate installation and make both known and unforeseen changes to other work required for substitution at no additional cost to the owner.

E. The proposed substitution will have no adverse effect on other trades, the construction schedule, or specified warranty requirements.

F. Maintenance and service parts will be locally available for the proposed substitution.

G. The undersigned further states that the function, appearance, and quality of the proposed substitutions are equivalent or superior to the specified item.

SUBMITTED BY: _____

SIGNATURE _____

FIRM _____

ADDRESS _____

_____

TELEPHONE (____) _____

FAX (____) _____

FOR USE BY C2AE

ACCEPTED **ACCEPTED AS NOTED**

NOT ACCEPTED **RECEIVED TOO LATE**

BY _____

DATE _____

REMARKS _____

SECTION 024119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Demolition and removal of selected portions of building or structure.

1.2 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
   1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.3 INFORMATIONAL SUBMITTALS

A. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician.

1.4 CLOSEOUT SUBMITTALS

A. Inventory of items that have been removed and salvaged.

1.5 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.6 FIELD CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   1. Hazardous materials will be removed by Owner before start of the Work.
   2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
   1. Maintain fire-protection facilities in service during selective demolition operations.

G. Arrange selective demolition schedule so as not to interfere with Owner's operations.

1.7 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

C. Inventory and record the condition of items to be removed and salvaged.

3.2 PREPARATION

A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
   1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
   2. Arrange to shut off utilities with utility companies.
   3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
   4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
      a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
      b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
      c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
      d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
      e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
      f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
      g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.4 PROTECTION

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

C. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
   1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
   2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
   3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
   4. Maintain fire watch during and for at least four hours after flame-cutting operations.
   5. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
   6. Dispose of demolished items and materials promptly.

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Removed and Reinstalled Items:
   1. Clean and repair items to functional condition adequate for intended reuse.
   2. Pack or crate items after cleaning and repairing. Identify contents of containers.
   3. Protect items from damage during transport and storage.
   4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.6 CLEANING

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
   1. Do not allow demolished materials to accumulate on-site.
   2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

C. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024119

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, and other pozzolans materials subject to compliance with requirements.

B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.3 ACTION SUBMITTALS

A. Product Data: For each of the following.
   1. Portland cement.
   2. Fly ash.
   3. Slag cement.
   4. Blended hydraulic cement.
   5. Aggregates.
   6. Admixtures:
      a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
   7. Vapor retarders.
   8. Liquid floor treatments.
   9. Curing materials.
   10. Joint fillers.

B. Design Mixtures: For each concrete mixture, include the following:
   1. Mixture identification.
   2. Minimum 28-day compressive strength.
   3. Durability exposure class.
   4. Maximum w/cm.
   5. Calculated equilibrium unit weight, for lightweight concrete.
   6. Slump limit.
   7. Air content.
   8. Nominal maximum aggregate size.

9. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
10. Intended placement method.
11. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Shop Drawings:
1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
a. Location of construction joints is subject to approval of the Architect.

D. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:
1. Concrete Class designation.
2. Location within Project.
3. Exposure Class designation.
4. Formed Surface Finish designation and final finish.
5. Final finish for floors.
6. Curing process.
7. Floor treatment if any.

1.4 INFORMATIONAL SUBMITTALS

A. Preconstruction Test Reports: For each mix design.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.
1. Include the following information in each test report:
a. Admixture dosage rates.
b. Slump.
c. Air content.
d. Seven-day compressive strength.
e. 28-day compressive strength.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and ACI 301.

1.8 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 301 and ACI 306.1.

B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS

A. Cementitious Materials:
   1. Portland Cement: ASTM C150/C150M

B. Normal-Weight Aggregates: ASTM C33/C33M, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.
   1. Alkali-Silica Reaction: Comply with one of the following:
      a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
      b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
      c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. for moderately reactive aggregate or 3 lb./cu. yd. for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301.
   2. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
   3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Air-Entraining Admixture: ASTM C260/C260M.

D. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride in steel-reinforced concrete.
   1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
   2. Retarding Admixture: ASTM C494/C494M, Type B.
   3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
   4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
   5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
   6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

E. Water and Water Used to Make Ice: ASTM C94/C94M, potable

2.3 VAPOR RETARDERS

A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A; not less than 10 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Raven Industries, Inc.
b. Reef Industries, Inc.
c. Stego Industries, LLC.
d. W. R. Meadows, Inc.

2.4 CURING MATERIALS

A. Water: Potable or complying with ASTM C1602/C1602M.

B. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ChemMasters, Inc.
b. Dayton Superior Corporation.
c. Euclid Chemical Company (The); an RPM company.

2.5 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork.

2.6 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.
1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Fly Ash or Other Pozzolans: 25 percent by mass.
2. Slag Cement: 50 percent by mass.
3. Total of Fly Ash or Other Pozzolans, Slag Cement: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass.
4. Total of Fly Ash or Other Pozzolans: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.
   1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
   2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M, and furnish batch ticket information.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.
   1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
   2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
   3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.
   1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
   3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.2 INSTALLATION OF VAPOR RETARDER

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.
   1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
   2. Face laps away from exposed direction of concrete pour.
   3. Lap vapor retarder over footings and grade beams not less than 6 inches, sealing vapor retarder to concrete.
   4. Lap joints 6 inches and seal with manufacturer's recommended tape.

5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
7. Protect vapor retarder during placement of reinforcement and concrete.
    a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides, and sealing to vapor retarder.

3.3 JOINTS

A. Construct joints true to line, with faces perpendicular to surface plane of concrete.

B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.
1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
2. Place joints perpendicular to main reinforcement.
    a. Continue reinforcement across construction joints unless otherwise indicated.
    b. Do not continue reinforcement through sides of strip placements of floors and slabs.
3. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
4. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

C. Control Joints in Slabs-On-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:
1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

D. Isolation Joints in Slabs-On-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.

2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface, where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints:
1. Install dowel bars and support assemblies at joints where indicated on Drawings.
2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.

F. Dowel Plates: Install dowel plates at joints where indicated on Drawings.

3.4 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.
1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.

B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.

C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete delivery ticket.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not to exceed the amount indicated on the concrete delivery ticket.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.
1. If a section cannot be placed continuously, provide construction joints as indicated.
2. Deposit concrete to avoid segregation.
3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.

4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.
    a. Do not use vibrators to transport concrete inside forms.
    b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
    c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
    d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Do not place concrete floors and slabs in a checkerboard sequence.
2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Maintain reinforcement in position on chairs during concrete placement.
4. Screed slab surfaces with a straightedge and strike off to correct elevations.
5. Level concrete, cut high areas, and fill low areas.
6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.5 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:
1. ACI 301 Surface Finish SF-3.0:
    a. Patch voids larger than 3/4-inch-wide or 1/2 inch deep.
    b. Remove projections larger than 1/8 inch.
    c. Patch tie holes.
    d. Surface Tolerance: ACI 117 Class A.
    e. Locations: Apply to concrete surfaces.

B. Related Unformed Surfaces:
1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces.
2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.6 FINISHING FLOORS AND SLABS

A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Float Finish:
   1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
   2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.
   3. Apply float finish to surfaces to receive trowel finish.

C. Trowel Finish:
   1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
   2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
   3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
   4. Do not add water to concrete surface.
   5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
   6. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
   7. Finish and measure surface, so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inchand also no more than 1/16 inch in 2 feet.

D. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset method. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.
   1. Coordinate required final finish with Architect before application.
   2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.
   1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
   2. Coordinate required final finish with Architect before application.

3.7 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling In:
   1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
   2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
   3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:
   1. Coordinate sizes and locations of concrete bases with actual equipment provided.
   2. Construct concrete bases 4 inches high unless otherwise indicated on Drawings, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
   3. Minimum Compressive Strength: 4000 psi at 28 days.
   4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
   6. Prior to pouring concrete, place and secure anchorage devices.
      a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
      b. Cast anchor-bolt insert into bases.
      c. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items.
   1. Cast-in inserts and accessories, as shown on Drawings.
   2. Screed, tamp, and trowel finish concrete surfaces.

3.8 CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
   1. Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
   2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
   3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h, calculated in accordance with ACI 305.1, before and during finishing operations.

B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:
   1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
   2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
   3. If forms remain during curing period, moist cure after loosening forms.
   4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:
      a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
      b. Continuous Sprinkling: Maintain concrete surface continuously wet.
      c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
      d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
      e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
         1) Recoat areas subject to heavy rainfall within three hours after initial application.
         2) Maintain continuity of coating and repair damage during curing period.

C. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:
   1. Begin curing immediately after finishing concrete.
   2. Interior Concrete Floors:
      a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:
         1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
            a) Lap edges and ends of absorptive cover not less than 12 inches.
            b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
         2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.
            a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
            b) Cure for not less than seven days.

         3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
            a) Water.
            b) Continuous water-fog spray.

b. Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:
    1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
        a) Lap edges and ends of absorptive cover not less than 12 inches.
        b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
    2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.
        a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
        b) Cure for not less than seven days.
    3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
        a) Water.
        b) Continuous water-fog spray.
c. Floors to Receive Polished Finish: Contractor has option of the following:
    1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
        a) Lap edges and ends of absorptive cover not less than 12 inches.
        b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
    2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
        a) Water.
        b) Continuous water-fog spray.
d. Floors to Receive Chemical Stain:
    1) As soon as concrete has sufficient set to permit application without marring concrete surface, install curing paper over entire area of floor.
    2) Install curing paper square to building lines, without wrinkles, and in a single length without end joints.
    3) Butt sides of curing paper tight; do not overlap sides of curing paper.
    4) Leave curing paper in place for duration of curing period, but not less than 28 days.
e. Floors to Receive Urethane Flooring:
    1) As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

2) Rewet absorptive cover, and cover immediately with polyethylene moisture-retaining cover with edges lapped 6 inches and sealed in place.
3) Secure polyethylene moisture-retaining cover in place to prohibit air from circulating under polyethylene moisture-retaining cover.
4) Leave absorptive cover and polyethylene moisture-retaining cover in place for duration of curing period, but not less than 28 days.

f. Floors to Receive Curing Compound:
1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Maintain continuity of coating, and repair damage during curing period.
4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.

g. Floors to Receive Curing and Sealing Compound:
1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.9 TOLERANCES

A. Conform to ACI 117.

3.10 APPLICATION OF LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.
1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than three days' old.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.
4. Rinse with water; remove excess material until surface is dry.
5. Apply a second coat in a similar manner if surface is rough or porous.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller in accordance with manufacturer's written instructions.

3.11 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.

B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
   1. Testing agency to be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
   2. Testing agency to immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
   3. Testing agency shall report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.
      a. Test reports to include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:
         1) Project name.
         2) Name of testing agency.
         3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
         4) Name of concrete manufacturer.
         5) Date and time of inspection, sampling, and field testing.
         6) Date and time of concrete placement.
         7) Location in Work of concrete represented by samples.
         8) Date and time sample was obtained.
         9) Truck and batch ticket numbers.
         10) Design compressive strength at 28 days.
         11) Concrete mixture designation, proportions, and materials.
         12) Field test results.
         13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
         14) Type of fracture and compressive break strengths at seven days and 28 days.

C. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.

D. Inspections:
   1. Headed bolts and studs.
   2. Verification of use of required design mixture.
   3. Concrete placement, including conveying and depositing.
   4. Curing procedures and maintenance of curing temperature.

5. Verification of concrete strength before removal of shores and forms from beams and slabs.
6. Batch Plant Inspections: On a random basis, as determined by Architect.

E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M shall be performed in accordance with the following requirements:
   1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
      a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
   2. Slump: ASTM C143/C143M:
      a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
      b. Perform additional tests when concrete consistency appears to change.
   3. Slump Flow: ASTM C1611/C1611M:
      a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
      b. Perform additional tests when concrete consistency appears to change.
   4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete;
      a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   5. Concrete Temperature: ASTM C1064/C1064M:
      a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
   6. Unit Weight: ASTM C567/C567M fresh unit weight of structural lightweight concrete.
      a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
      b. and one set of two specimens at 28 days.
      c. A compressive-strength test to be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
   7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor to evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
   8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.
   9. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

10. Additional Tests:
    a. Testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
    b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
        1) Acceptance criteria for concrete strength to be in accordance with ACI 301, Section 1.6.6.3.
11. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within 72 hours of completion of floor finishing and promptly report test results to Architect.

3.12 PROTECTION

A. Protect concrete surfaces as follows:
1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.
8. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using Floor Slab Protective Covering.

END OF SECTION 033000

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Concrete masonry units.
   2. Brick.
   3. Mortar and grout materials.
   4. Reinforcement.
   5. Embedded flashing.
   6. Accessories.
   7. Mortar and grout mixes.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 FIELD CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602.

B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602.

PART 2 - PRODUCTS

2.1 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602, except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.
   1. Where fire-resistance-rated construction is indicated.

2.2 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
   1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

B. CMUs: ASTM C90, normal weight.
   1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2800 psi.

2.3 BRICK

A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:
   1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
   2. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

B. Clay Face Brick: Facing brick complying with ASTM C216, Grade SW, Type FBX.
   1. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested in accordance with ASTM C67/C67M.
   2. Efflorescence: Provide brick that has been tested in accordance with ASTM C67/C67M and is rated "not effloresced."
   3. Surface Coating: Brick with colors or textures produced by application of coatings withstand 50 cycles of freezing and thawing in accordance with ASTM C67/C67M with no observable difference in the applied finish when viewed from 10 ft.

2.4 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
   1. Alkali content will not be more than 0.1 percent when tested in accordance with ASTM C114.

B. Hydrated Lime: ASTM C207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Masonry Cement: ASTM C91/C91M.

E. Aggregate for Mortar: ASTM C144.
   1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
   2. For joints less than 1/4-inch-thick, use aggregate graded with 100 percent passing the No. 16 sieve.

F. Aggregate for Grout: ASTM C404.

G. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

H. Water: Potable.

2.5 REINFORCEMENT

A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60.

B. Masonry-Joint Reinforcement, General: ASTM A951/A951M.
   1. Exterior Walls: Hot-dip galvanized carbon steel.
   2. Wire Size for Side Rods: 0.148-inch diameter.
   3. Wire Size for Cross Rods: 0.148-inch diameter.
   4. Wire Size for Veneer Ties: 0.148-inch diameter.
   5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
   6. Provide in lengths of not less than 10 ft.

C. Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods.

D. Masonry-Joint Reinforcement for Multiwythe Masonry:
   1. Ladder type with one side rod at each face shell of hollow masonry units more than 4 inches wide, plus one side rod at each wythe of masonry 4 inches wide or less.
   2. Tab type, either ladder or truss design, with one side rod at each face shell of backing wythe and with rectangular tabs sized to extend at least halfway through facing wythe, but with at least 5/8-inch cover on outside face.
   3. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum horizontal play of 1/16 inch and maximum vertical adjustment of 1-1/4 inches. Size ties to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face. Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe.

2.6 EMBEDDED FLASHING

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
   1. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.016 inch thick.
   2. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 ft. Provide splice plates at joints of formed, smooth metal flashing.
   3. Fabricate metal drip edges from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
   4. Fabricate metal sealant stops from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.

B. Flexible Flashing: Use the following unless otherwise indicated:
   1. Self-Adhering, Stainless Steel Fabric Flashing: Composite, flashing product consisting of 2 mil of Type 304 stainless steel sheet, bonded to a layer of polymeric fabric with a butyl adhesive, to produce an overall thickness of 40 mil.
      a. Applications: Use 10-mil-thick flashing at windows, doors, and small wall penetrations; not at base of walls. Use 40-mil-thick flashing at base of walls.

C. Solder and Sealants for Sheet Metal Flashings: As specified in Section 076200 "Sheet Metal Flashing and Trim."

D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

E. Termination Bars for Flexible Flashing: Aluminum bars 1/8 inch by 1 inch.

F. Termination Bars for Flexible Flashing, Flanged: Stainless steel sheet 0.019 inch by 1-1/2 inches with a 3/8-inch flange at top.

2.7 ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene urethane or PVC.

B. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

C. Weep/Cavity Vents: Use the following unless otherwise indicated:
   1. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from manufacturer's standard.

D. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
   1. Mortar Deflector: Strips, full depth of cavity and 16 inches high, with dovetail-shaped notches that prevent clogging with mortar droppings.

E. Proprietary Acidic Masonry Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

2.8 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
   1. Do not use calcium chloride in mortar or grout.
   2. Use portland cement-lime mortar unless otherwise indicated.
   3. For exterior masonry, use portland cement-lime mortar.
   4. For reinforced masonry, use portland cement-lime mortar.
   5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
   1. For masonry below grade or in contact with earth, use Type M.
   2. For reinforced masonry, use Type M.
   3. For exterior, above-grade, load-bearing, nonload-bearing walls, and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.

D. Grout for Unit Masonry: Comply with ASTM C476.
   1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602 for dimensions of grout spaces and pour height.
   2. Proportion grout in accordance with ASTM C476, Table 1 or paragraph 4.2.1.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
   3. Provide grout with a slump of 8 to 11 inches as measured in accordance with ASTM C143/C143M.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

C. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested in accordance with ASTM C67/C67M. Allow units to absorb water so they are damp but not wet at time of laying.

3.2 TOLERANCES

A. Dimensions and Locations of Elements:
   1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
   2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
   3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:
   1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 ft., or 1/2-inch maximum.
   2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 ft., 1/4 inch in 20 ft., or 1/2-inch maximum.
   3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2-inch maximum.
   4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 ft., 1/4 inch in 20 ft., or 1/2-inch maximum.
   5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2-inch maximum.
   6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 ft., or 1/2-inch maximum.

C. Joints:
   1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
   2. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
   3. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.

3.3 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry to match existing; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

D. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

E. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.4 MORTAR BEDDING AND JOINTING

A. Lay CMUs and hollow brick as follows:
   1. Bed face shells in mortar and make head joints of depth equal to bed joints.
   2. Bed webs in mortar in all courses of piers, columns, and pilasters.
   3. Bed webs in mortar in grouted masonry, including starting course on footings.
   4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
   5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Lay structural clay tile as follows:
   1. Lay vertical-cell units with full head joints unless otherwise indicated. Provide bed joints with full mortar coverage on face shells and webs.

   2. Lay horizontal-cell units with full bed joints unless otherwise indicated. Keep drainage channels, if any, free of mortar. Form head joints with sufficient mortar so excess will be squeezed out as units are placed in position. Butter both sides of units to be placed, or butter one side of unit already in place and one side of unit to be placed.
   3. Maintain joint thicknesses indicated except for minor variations required to maintain bond alignment. If not indicated, lay walls with 1/4- to 3/8-inch-thick joints.

D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.5 CAVITY WALLS

A. Bond wythes of cavity walls together using one of the following methods:
   1. Individual Metal Ties: Provide ties as indicated installed in horizontal joints, but not less than one metal tie for 2.67 sq. ft. of wall area spaced not to exceed 16 inches o.c. horizontally and 16 inches o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches o.c. vertically.
   2. Masonry-Joint Reinforcement: Installed in horizontal mortar joints.
      a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes.
      b. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) reinforcement with continuous horizontal wire in facing wythe attached to ties.
      c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable-type (two-piece-type) reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.

B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

C. Installing Cavity Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as indicated.

3.6 MASONRY-JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
   1. Space reinforcement not more than 16 inches o.c.
   2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
   3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

3.7 FLASHING, WEEP HOLES, AND CAVITY VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install cavity vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.

B. Install flashing as follows unless otherwise indicated:
   1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
   2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches, and through inner wythe to within 1/2 inch of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately 2 inches on interior face.
   3. At lintels and shelf angles, extend flashing 6 inches minimum at each end. At heads and sills, extend flashing 6 inches minimum and turn ends up not less than 2 inches to form end dams.
   4. Install metal drip edges with sawtooth sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
   5. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
   6. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.

C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

D. Install weep holes in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.
   1. Use specified weep/cavity vent products to form weep holes.
   2. Space weep holes 24 inches o.c. unless otherwise indicated.
   3. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.

E. Place cavity drainage material in airspace behind veneers to comply with configuration requirements for cavity drainage material in "Accessories" Article.

F. Install cavity vents in head joints in exterior wythes at spacing indicated. Use specified weep/cavity vent products to form cavity vents.
   1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.8 REINFORCED UNIT MASONRY

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
   1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
   2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
   1. Comply with requirements in TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
   2. Limit height of vertical grout pours to not more than 60 inches.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements will be at Contractor's expense.

B. Testing Prior to Construction: One set of tests.

C. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

D. Clay Masonry Unit Test: For each type of unit provided, in accordance with ASTM C67/C67M for compressive strength.

E. Concrete Masonry Unit Test: For each type of unit provided, in accordance with ASTM C140/C140M for compressive strength.

F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, in accordance with ASTM C780.

G. Mortar Test (Property Specification): For each mix provided, in accordance with ASTM C780. Test mortar for mortar air content and compressive strength.

H. Grout Test (Compressive Strength): For each mix provided, in accordance with ASTM C1019.

3.10 CLEANING

A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
   3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
   4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
   5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
   6. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.
   7. Clean masonry with a proprietary acidic masonry cleaner applied according to manufacturer's written instructions.

3.11 MASONRY WASTE DISPOSAL

A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
   1. Do not dispose of masonry waste as fill within 18 inches of finished grade.

B. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Miscellaneous framing and supports.
   2. Shelf angles.

B. Products furnished, but not installed, under this Section include the following:
   1. Loose steel lintels.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Nonslip aggregates and nonslip-aggregate surface finishes.
   2. Shop primers.
   3. Shrinkage-resisting grout.

B. Shop Drawings: Show fabrication and installation details.

PART 2 - PRODUCTS

2.1 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications 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 A36/A36M.

2.2 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

2.3 MISCELLANEOUS MATERIALS

A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
   1. Use primer that contains pigments that make it easily distinguishable from zinc-rich primer.

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

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

D. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.4 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. 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.

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

D. Weld corners and seams continuously to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

E. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

F. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

G. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, not less than 8 inches from ends and corners of units and 24 inches o.c.

2.5 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

2.6 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Galvanize loose steel lintels located in exterior walls.

2.7 GENERAL FINISH REQUIREMENTS

A. Finish metal fabrications after assembly.

2.8 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
   1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

A. Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.3 REPAIRS

A. Touchup Painting:
   1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055000

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Framing with dimension lumber.
   2. Miscellaneous lumber.
   3. Fire-retardant-treated lumber.

1.2 ACTION SUBMITTALS

A. Product Data:
   1. For each type of process and factory-fabricated product.
   2. For preservative-treated wood products.

1.3 INFORMATIONAL SUBMITTALS

A. Material Certificates:
   1. For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
   2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.

B. Evaluation Reports: For the following, from ICC-ES:
   1. Wood-preservative-treated wood.
   2. Fire-retardant-treated wood.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: Comply with DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
   1. Factory mark each piece of lumber with grade stamp of grading agency.
   2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
   3. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content:
   1. Boards: 15 percent.
   2. Dimension Lumber: 15 percent for 2-inch nominal thickness or less; 19 percent for more than 2-inch nominal thickness unless otherwise indicated.

C. Engineered Wood Products: Acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
   1. Allowable design stresses, as published by manufacturer, are to meet or exceed those indicated. Manufacturer's published values are to be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.2 PRESERVATIVE TREATMENT

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
   1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat items indicated on Drawings, and the following:
   1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
   2. Wood sills, sleepers, blocking, furring, and similar concealed members in contact with masonry or concrete.
   3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
   4. Wood framing members that are less than 18 inches above the ground in crawlspaces or unexcavated areas.
   5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATMENT

A. General: Where fire-retardant-treated materials are indicated, materials are to comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
   1. Exterior Type: Treated materials are to comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
   2. Interior Type A: Treated materials are to have a moisture content of 28 percent or less when tested according to ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.

C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

E. Application: Treat items indicated on Drawings, and the following:
   1. Framing for raised platforms.
   2. Framing for stages.
   3. Concealed blocking.
   4. Framing for non-load-bearing partitions.
   5. Framing for non-load-bearing exterior walls.
   6. Roof construction.
   7. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

A. Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
   1. Blocking.
   2. Nailers.

B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.

C. Concealed Boards: 15 percent maximum moisture content and any of the following species and grades:
   1. Mixed southern pine or southern pine; No. 2 grade; SPIB.
   2. Eastern softwoods; No. 2 Common grade; NeLMA.

   3. Northern species; No. 2 Common grade; NLGA.
   4. Western woods; Construction or No. 2 Common grade; WCLIB or WWPA.

2.5 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, A-C, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2-inch nominal thickness.

2.6 FASTENERS

A. General: Fasteners are to be of size and type indicated and comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches into wood substrate.
   1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.

B. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

C. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 ICC-ES AC58 ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate.

2.7 METAL FRAMING ANCHORS

A. Products: Subject to compliance with requirements, provide the following:

   1. MiTek Industries, Inc.;.

B. Allowable design loads, as published by manufacturer, are to meet or exceed those indicated. Manufacturer's published values are to be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency. Framing anchors are to be punched for fasteners adequate to withstand same loads as framing anchors.

C. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M, G60 coating designation.
   1. Use for interior locations unless otherwise indicated.

D. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A653/A653M; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 coating designation; and not less than 0.036 inch thick.
   1. Use for wood-preservative-treated lumber and where indicated.

2.8 MISCELLANEOUS MATERIALS

A. Sill-Sealer Gaskets:
   1. Glass-fiber-resilient insulation, fabricated in strip form, for use as a sill sealer; 1-inch nominal thickness, compressible to 1/32 inch; selected from manufacturer's standard widths to suit width of sill members indicated.
   2. Closed-cell neoprene foam, 1/4-inch-thick, selected from manufacturer's standard widths to suit width of sill members indicated.

3. Self-adhering sheet consisting of 64mils of rubberized asphalt laminated on one side to a 4-mil-thick, polyethylene-film reinforcement, and with release liner on adhesive side; formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.

B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch.

C. Adhesives for Gluing Furring to Concrete or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

B. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.

C. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.

D. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

E. Do not splice structural members between supports unless otherwise indicated.

F. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

G. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

H. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code (IBC).
2. ICC-ES evaluation report for fastener.

3.2 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061000

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Manufactured reglets with counterflashing.
   2. Formed low-slope roof sheet metal fabrications.
   3. Formed wall sheet metal fabrications.

1.2 ACTION SUBMITTALS

A. Product Data: For each of the following
   1. Underlayment materials.
   2. Elastomeric sealant.
   3. Butyl sealant.

B. Shop Drawings: For sheet metal flashing and trim.
   1. Include plans, elevations, sections, and attachment details.
   2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
   3. Include identification of material, thickness, weight, and finish for each item and location in Project.
   4. Include details for forming, including profiles, shapes, seams, and dimensions.
   5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
   6. Include details of termination points and assemblies.
   7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
   8. Include details of roof-penetration flashing.
   9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
   10. Include details of special conditions.
   11. Include details of connections to adjoining work.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

B. Special warranty.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
   1. For copings and roof edge flashings that are ANSI/SPRI/FM 4435/ES-1 tested, shop is to be listed as able to fabricate required details as tested and approved.

1.5 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
      b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SHEET METALS

A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Stainless Steel Sheet: ASTM A240/A240M, Type 304, dead soft, fully annealed; with smooth, flat surface.
   1. Finish: ASTM A480/A480M, No. 2D (dull, cold rolled).

2.3 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet Underlayment: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer in accordance with underlayment manufacturer's written instructions.
   1. Low-Temperature Flexibility: ASTM D1970/D1970M; passes after testing at minus 20 deg F or lower.

B. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. minimum.

2.4 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal.
   1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
      a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
      b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
      c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
   2. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.

C. solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2-inch-wide and 1/8 inch thick.

D. Elastomeric Sealant: ASTM C920, elastomeric polyurethane polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

F. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.

G. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

H. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions.
   1. Material: Stainless steel, 0.0188 inch thick.
   2. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
   3. Accessories:
      a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
      b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge.
   4. Finish: Mill.

2.5 FABRICATION, GENERAL

A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
   1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
   2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
   3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
   4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
   5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances:
   1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.

C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
1. Form expansion joints of intermeshing hooked flanges, not less than 1-inch-deep, filled with butyl sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Seams:
1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
3. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.

2.6 WALL SHEET METAL FABRICATIONS

A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch-long, but not exceeding 12-foot-long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings; and form with 2-inch-high, end dams. Fabricate from the following materials:
1. Stainless Steel: 0.0156 inch thick.

PART 3 - EXECUTION

3.1 INSTALLATION OF UNDERLAYMENT

A. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim.
1. Install in shingle fashion to shed water.
2. Lap joints not less than 2 inches.

B. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, in accordance with manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.
1. Lap horizontal joints not less than 4 inches.
2. Lap end joints not less than 12 inches.

C. Self-Adhering, High-Temperature Sheet Underlayment:
   1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
   2. Prime substrate if recommended by underlayment manufacturer.
   3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
   4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses.
   5. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller.
   6. Roll laps and edges with roller.
   7. Cover underlayment within 14 days.

3.2 INSTALLATION, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.
   1. Install fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
   2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of sealant.
   3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
   4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
   5. Install continuous cleats with fasteners spaced not more than 12 inches o.c.
   6. Space individual cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
   7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
   8. Do not field cut sheet metal flashing and trim by torch.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
   1. Coat concealed side of stainless steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
   2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
   1. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
   2. Form expansion joints of intermeshing hooked flanges, not less than 1-inch-deep, filled with sealant concealed within joints.
   3. Use lapped expansion joints only where indicated on Drawings.

D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction.
   1. Use sealant-filled joints unless otherwise indicated.
      a. Embed hooked flanges of joint members not less than 1 inch into sealant.
      b. Form joints to completely conceal sealant.
      c. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
      d. Adjust setting proportionately for installation at higher ambient temperatures.
         1) Do not install sealant-type joints at temperatures below 40 deg F.
   2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.3 INSTALLATION OF ROOF FLASHINGS

A. Install sheet metal flashing and trim to comply with performance requirements and cited sheet metal standard.
   1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
   2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.
   1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
   2. Extend counterflashing 4 inches over base flashing.
   3. Lap counterflashing joints minimum of 4 inches.

3.4 INSTALLATION OF WALL FLASHINGS

A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

3.5 INSTALLATION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.6 CLEANING

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder.

C. Clean off excess sealants.

3.7 PROTECTION

A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 076200

SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Roof curbs.
   2. Equipment supports.
   3. Pipe and duct supports.
   4. Pipe portals.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of roof accessory.

B. Shop Drawings: For roof accessories.

C. Samples: For each exposed product and for each color and texture specified.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ROOF CURBS

A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, straight sides, and integrally formed deck-mounting flange at perimeter bottom.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. AES Industries, Inc.
      b. Air Balance; a division of MESTEK, Inc.
      c. Curbs Plus, Inc.
      d. Greenheck Fan Corporation.

e. LMCurbs.
f. Pate Company (The).
g. Roof Products, Inc.
h. Thybar Corporation.

B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

C. Material: Zinc-coated (galvanized) steel sheet, 0.052 inch thick.
1. Finish: Baked enamel or powder coat.
2. Color: As selected by Architect from manufacturer's full range.

D. Material: Stainless steel sheet, 0.0781 inch thick.
1. Finish: Manufacturer's standard.

E. Construction:
1. Curb Profile: Manufacturer's standard compatible with roofing system.
2. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
3. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
4. Top Surface: Level top of curb, with roof slope accommodated by sloping deck-mounting flange.
5. Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.
6. Insulation: Factory insulated with 1-1/2-inch- thick glass-fiber board insulation.
7. Liner: Same material as curb, of manufacturer's standard thickness and finish.
8. Nailer: Factory-installed wood nailer along top flange of curb, continuous around curb perimeter.
9. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.
10. Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from 3/4-inch-thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
11. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.
12. Damper Tray: Provide damper tray or shelf with opening 3 inches.

2.2 EQUIPMENT SUPPORTS

A. Equipment Supports: Rail-type metal equipment supports capable of supporting superimposed live and dead loads between structural supports, including equipment loads and other construction indicated on Drawings, spanning between structural supports; capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, and integrally formed structure-mounting flange at bottom.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. AES Industries, Inc.
    b. Air Balance; a division of MESTEK, Inc.
    c. Curbs Plus, Inc.
    d. Greenheck Fan Corporation.
    e. LMCurbs.
    f. Pate Company (The).
    g. Roof Curb Systems.
    h. Thybar Corporation.

B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

C. Material: Zinc-coated (galvanized) steel sheet, 0.052 inch thick.
1. Finish: Baked enamel or powder coat.
2. Color: As selected by Architect from manufacturer's full range.

D. Material: Stainless steel sheet, 0.0781 inch thick.
1. Finish: Manufacturer's standard.

E. Construction:
1. Curb Profile: Manufacturer's standard compatible with roofing system.
2. Liner: Same material as equipment support, of manufacturer's standard thickness and finish.
3. Nailer: Factory-installed continuous wood nailers 3-1/2 inches wide on top flange of equipment supports, continuous around support perimeter.
4. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb of size and spacing required to meet wind uplift requirements.
5. Platform Cap: Where portion of equipment support is not covered by equipment, provide weathertight platform cap formed from 3/4-inch-thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
6. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
7. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.

8. Fabricate equipment supports to minimum height of 12 inches above roofing surface unless otherwise indicated.
9. Sloping Roofs: Where roof slope exceeds 1:48, fabricate each support with height to accommodate roof slope so that tops of supports are level with each other. Equip supports with water diverters or crickets on sides that obstruct water flow.

2.3 PIPE AND DUCT SUPPORTS

A. Fixed-Height Cradle-Type Pipe Supports: Polycarbonate pipe stand accommodating up to 1-1/2-inch- (38-mm-) diameter pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.

B. Fixed-Height Roller-Bearing Pipe Supports: Polycarbonate pipe stand with polycarbonate roller carrying assembly accommodating up to 7-inch- (178-mm-) diameter pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.

C. Adjustable-Height Roller-Bearing Pipe Supports: Polycarbonate pipe stand base, pipe support, and roller housing, with stainless steel threaded rod designed for adjusting support height, accommodating up to 18 inch (457 mm) diameter pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.

2.4 PIPE PORTALS

A. Flashing Pipe Portal: Formed aluminum membrane-mounting flashing flange and sleeve with collared opening and pressure-sealed conically shaped EPDM protective rubber cap sized for piping indicated, with stainless steel snaplock swivel clamps.

2.5 METAL MATERIALS

A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 coating designation.
   1. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
   2. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.

3. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.
4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

B. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, AZ50 coated.
1. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
2. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.
3. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.
4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

C. Aluminum Extrusions and Tubes: ASTM B221, manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.

D. Stainless Steel Sheet and Shapes: ASTM A240/A240M or ASTM A666, Type 304.

E. Steel Shapes: ASTM A36/A36M, hot-dip galvanized according to ASTM A123/A123M unless otherwise indicated.

F. Steel Tube: ASTM A500**/**A500M, round tube.

G. Galvanized-Steel Tube: ASTM A500**/**A500M, round tube, hot-dip galvanized according to ASTM A123/A123M.

H. Steel Pipe: ASTM A53/A53M, galvanized.

2.6 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.

C. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches thick.

D. Underlayment:
   1. Felt: ASTM D226**/**D226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
   2. Polyethylene Sheet: 6-mil-thick polyethylene sheet complying with ASTM D4397.
   3. Slip Sheet: Building paper, 3 lb/100 sq. ft. minimum, rosin sized.
   4. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

E. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:

F. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

G. Elastomeric Sealant: ASTM C920, elastomeric polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

H. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

I. Asphalt Roofing Cement: ASTM D4586**/**D4586M, asbestos free, of consistency required for application.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify dimensions of roof openings for roof accessories. Install roof accessories according to manufacturer's written instructions.
   1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
   2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
   3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
   4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
   1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
   2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.

C. Pipe Support Installation: Comply with MSS SP-58 and MSS SP-89. Install supports and attachments as required to properly support piping. Arrange for grouping of parallel runs of horizontal piping, and support together.

   1. Pipes of Various Sizes: Space supports for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

D. Preformed Flashing-Sleeve and Flashing-Pipe Portal Installation: Secure flashing sleeve to roof membrane according to flashing-sleeve manufacturer's written instructions; flash sleeve flange to surrounding roof membrane according to roof membrane manufacturer's instructions.

E. Seal joints with butyl sealant as required by roof accessory manufacturer.

3.2 REPAIR AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A780**/**A780M.

B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 099113 "Exterior Painting."

C. Clean exposed surfaces according to manufacturer's written instructions.

D. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Penetrations in fire-resistance-rated walls.

1.2 ACTION SUBMITTALS

A. Product data.

B. Sustainable Design Submittals:
   1. Product Data: For sealants, indicating VOC content.
   2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.
   1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines. Obtain approval of authorities having jurisdiction prior to submittal.

1.3 INFORMATIONAL SUBMITTALS

A. Listed system designs.

1.4 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:
   1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
   2. Test in accordance with testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:
      a. Penetration firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with listed system designs published by a qualified testing agency.
         1) UL in its online directory "Product iQ."
         2) Intertek Group in its "Directory of Building Products."
         3) FM Approvals in its "Approval Guide."

2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Description: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems are to be compatible with one another, with the substrates forming openings, and with penetrating items if any.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. 3M Building and Construction.
      b. Hilti, Inc.
      c. Passive Fire Protection Partners.
      d. Specified Technologies, Inc.
      e. Tremco Incorporated.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined in accordance with ASTM E814 or UL 1479.
   1. F-Rating: Not less than the fire-resistance rating of the wall penetrated.
   2. Membrane Penetrations: Install recessed fixtures such that the required fire resistance will not be reduced.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined in accordance with ASTM E814 or UL 1479.
   1. F-Rating: At least one hour, but not less than the fire-resistance rating of the floor penetrated.
   2. T-Rating: At least one hour, but not less than the fire-resistance rating of the floor. The following floor penetrations do not require a T-rating:
      a. Those within the cavity of a wall.
      b. Floor, tub, or shower drains within a concealed space.
      c. 4-inch or smaller metal conduit penetrating directly into metal-enclosed electrical switchgear.

3. W-Rating: Provide penetration firestopping systems with a Class 1 W-rating in accordance with UL 1479.

D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined in accordance with UL 1479.
   1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.

E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, in accordance with ASTM E84.
   1. Verify sealant has a VOC content of 250 g/L or less.

F. 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 system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

PART 3 - EXECUTION

3.1 INSTALLATION OF PENETRATION FIRESTOPPING SYSTEMS

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. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

C. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
   1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

D. Install fill materials by proven techniques to produce the following results:
   1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
   2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
   3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.2 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.
   1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
   1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
   2. Contractor's name, address, and phone number.
   3. Designation of applicable testing and inspecting agency.
   4. Date of installation.
   5. Manufacturer's name.
   6. Installer's name.

3.3 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

END OF SECTION 078413

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Silicone joint sealants.
   2. Nonstaining silicone joint sealants.
   3. Urethane joint sealants.
   4. Latex joint sealants.

1.2 ACTION SUBMITTALS

A. Product data.

B. Samples: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Joint-sealant schedule.

1.3 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports: For field-adhesion-test reports, for each sealant application tested.

B. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Warranty Documentation:
   1. Manufacturers' special warranties.
   2. Installer's special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified in accordance with ASTM C1021 to conduct the testing indicated.

1.6 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
   1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
   2. Disintegration of joint substrates from causes exceeding design specifications.
   3. Mechanical damage caused by individuals, tools, or other outside agents.
   4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

A. Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Adfast.
      b. GE Construction Sealants; Momentive Performance Materials Inc.
      c. Sika Corporation - Building Components.

2.3 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested in accordance with ASTM C1248.

B. Silicone, Nonstaining, S, NS, 100/50, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Adfast.
      b. Pecora Corporation.
      c. Sika Corporation - Building Components.
      d. Tremco Incorporated.

2.4 URETHANE JOINT SEALANTS

A. Urethane, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Bostik; Arkema.
      b. Master Builders Solutions.
      c. Pecora Corporation.
      d. Polymeric Systems, Inc.
      e. Sherwin-Williams Company (The).
      f. Sika Corporation - Building Components.
      g. Tremco Incorporated.

2.5 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Everkem Diversified Products, Inc.
      b. Pecora Corporation.
      c. Sherwin-Williams Company (The).
      d. Tremco Incorporated.

2.6 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Alcot Plastics Ltd.
   b. Construction Foam Products; a division of Nomaco, Inc.
   c. Master Builders Solutions.

B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin) Type O (open-cell material) Type B (bicellular material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.7 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
   1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

   2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
      a. Concrete.

b. Masonry.
c. Unglazed surfaces of ceramic tile.
d. Exterior insulation and finish systems.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
   a. Metal.
   b. Glass.
   c. Porcelain enamel.
   d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.2 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.
   3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.

2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants in accordance with requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.
4. Provide flush joint profile at in accordance with Figure 8B in ASTM C1193.

5. Provide recessed joint configuration of recess depth and at locations indicated on Drawings in accordance with Figure 8C in ASTM C1193.
   a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

G. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

H. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 079200

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Framing systems.
   2. Suspension systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each product.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of code-compliance certification for studs and tracks.

1.4 QUALITY ASSURANCE

A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association the Steel Framing Industry Association the Steel Stud Manufacturers Association or the Supreme Steel Framing System Association.

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, in accordance with ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, in accordance with ASTM E90 and classified in accordance with ASTM E413 by an independent testing agency.

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C645 for conditions indicated.
   1. Steel Sheet Components: Comply with ASTM C645 requirements for metal unless otherwise indicated
   2. Protective Coating: Comply with ASTM C645; ASTM A653/A653M, G40; or coating with equivalent corrosion resistance. Galvannealed products are unacceptable.
      a. Coating demonstrates equivalent corrosion resistance with an evaluation report acceptable to authorities having jurisdiction.

B. Studs and Track: ASTM C645.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ClarkDietrich.
      b. Marino\WARE.
      c. Steel Network, Inc. (The).
      d. Telling Industries.
   2. Minimum Base-Steel Thickness: As required by performance requirements for horizontal deflection.
   3. Depth: As indicated on Drawings.

C. Hat-Shaped, Rigid Furring Channels:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ClarkDietrich.
      b. Jaimes Industries.
      c. Marino\WARE.
      d. Steel Construction Systems; Stone Group of Companies.
   2. Minimum Base-Steel Thickness: 0.0296 inch.
   3. Depth: As indicated on Drawings.

D. Resilient Furring Channels: 1/2-inch-deep, steel sheet members designed to reduce sound transmission.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ClarkDietrich.
      b. Marino\WARE.
      c. Steel Construction Systems; Stone Group of Companies.
   2. Configuration: Asymmetrical.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.

B. Hanger Attachments to Concrete:
   1. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 AC193 AC58 or AC308 as appropriate for the substrate.
      a. Uses: Securing hangers to structure.
      b. Type: Torque-controlled, expansion anchor.
      c. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
      d. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel bolts, ASTM F593, and nuts, ASTM F594.

C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

D. Flat Hangers: Steel sheet, 1 by 3/16 inch by length indicated.

E. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch and minimum 1/2-inch-wide flanges.
   1. Depth: 2-1/2 inches.

F. 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 Tracks: Use either conventional steel studs and tracks or embossed, high-strength steel studs and tracks.
      a. Minimum Base-Steel Thickness: 0.0190 inch.
      b. Depth: As indicated on Drawings.
   3. Hat-Shaped, Rigid Furring Channels: 7/8 inch deep.
      a. Minimum Base-Steel Thickness: 0.0296 inch.
   4. Resilient Furring Channels: 1/2-inch-deep members designed to reduce sound transmission.
      a. Configuration: Asymmetrical.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.
   1. Fasteners for Steel 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 D226/D226M, 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 INSTALLATION, GENERAL

A. Installation Standard: ASTM C754.
   1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C841 that apply to framing installation.
   2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C1063 that apply to framing installation.
   3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C844 that apply to framing installation.
   4. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 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.

3.2 INSTALLATION OF FRAMING SYSTEMS

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks 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 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.
      a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
   5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
   6. Curved Partitions:
      a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
      b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches o.c.

E. Direct Furring:
   1. Screw to wood framing.
   2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

F. 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.
   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.

G. 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.

3.3 INSTALLATION OF SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
      a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
   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. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
   5. Do not attach hangers to steel roof deck.
   6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
   7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
   8. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

3.4 FIELD QUALITY CONTROL

A. 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 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Interior gypsum board.

1.2 ACTION SUBMITTALS

A. Product data.

B. Shop Drawings: Show locations and installation of control and expansion joints, including plans, elevations, sections, details of components, and attachments to other work.

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 in accordance with ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated in accordance with ASTM E90 and classified in accordance with ASTM E413 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. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Gypsum.
      b. CertainTeed; SAINT-GOBAIN.
      c. Continental Building Products Inc.
      d. Georgia-Pacific Gypsum LLC.
      e. USG Corporation.

2. Core: 5/8 inch, Type X.
3. Long Edges: Tapered.
4. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

2.4 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047.
   1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
   2. Shapes:
      a. Cornerbead.
      b. Bullnose bead.
      c. LC-Bead: J-shaped; exposed long flange receives joint compound.
      d. L-Bead: L-shaped; exposed long flange receives joint compound.
      e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
      f. Expansion (control) joint.
      g. Curved-Edge Cornerbead: With notched or flexible flanges.

2.5 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M.

B. Joint Tape:
   1. Interior Gypsum Board: Paper.
   2. Exterior Gypsum Soffit Board: Paper.
   3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
   4. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
   1. Prefilling: At open joints 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 setting-type, sandable topping compound.
   5. Skim Coat: For final coat of Level 5 finish, use high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.

D. Joint Compound for Exterior Applications:
   1. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.
   2. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.

2.6 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
   1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
   2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

D. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
   1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

E. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

F. Vapor Retarder: As specified in Section 072600 "Vapor Retarders."

PART 3 - EXECUTION

3.1 INSTALLATION OF PANELS

A. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

B. Comply with ASTM C840.

C. 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.

D. 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.

3.2 FINISHING OF GYPSUM BOARD

A. Prefill open joints and damaged surface areas.

B. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

C. Gypsum Board Finish Levels: Finish panels to levels indicated below and in accordance with ASTM C840:
   1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
   2. Level 2: Panels that are substrate for tile.
   3. Level 3: Where indicated on Drawings.
   4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
      a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
   5. Level 5: Where indicated on Drawings.
      a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

3.3 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

END OF SECTION 092900

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Thermoplastic-rubber base.
   2. Rubber molding accessories.

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.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC-RUBBER BASE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong Flooring, Inc.
   2. Johnsonite; a Tarkett company.
   3. Roppe Corporation.
   4. VPI Corporation.

B. Product Standard: ASTM F1861, Type TP (rubber, thermoplastic).
   1. Group: I (solid, homogeneous).
   2. Style and Location:
      a. Style B, Cove

C. Thickness: 0.125 inch.

D. Height: Match existing.

E. Lengths: Coils in manufacturer's standard length.

F. Outside Corners: Job formed.

G. Inside Corners: Job formed.

H. Colors: Match existing.

2.2 RUBBER MOLDING ACCESSORY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Roppe Corporation.
   2. VPI Corporation.

B. Description: Rubber transition strips.

C. Profile and Dimensions: Match existing.

D. Colors and Patterns: Match existing.

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. Verify adhesives have a VOC content of 50 g/L or less.

C. Stair-Tread Nose Filler: Two-part epoxy compound recommended by resilient stair-tread manufacturer to fill nosing substrates that do not conform to tread contours.

D. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient stair-tread manufacturer.

PART 3 - EXECUTION

3.1 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 materials are the same temperature as space where they are to be installed.

D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.2 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. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

H. 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.
      a. Miter or cope corners to minimize open joints.

3.3 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Stair Accessories:
   1. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
   2. Tightly adhere to substrates throughout length of each piece.
   3. For treads installed as separate, equal-length units, install to produce a flush joint between units.

C. 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.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513

SECTION 096519 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Vinyl composition floor tile.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and pattern specified.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For resilient floor tile, as determined by testing identical products according to ASTM E648 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong Flooring, Inc.
   2. Armstrong World Industries, Inc.
   3. Congoleum Flooring.
   4. Johnsonite; a Tarkett company.

B. Tile Standard: ASTM F1066.

C. Wearing Surface: Smooth.

D. Thickness: 0.125 inch.

E. Size: 12 by 12 inches.

F. Colors and Patterns: Match existings.

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. Verify adhesives have a VOC content of 50 g/L or less.

C. Floor Polish: Provide protective, liquid floor-polish products recommended by floor tile manufacturer.

PART 3 - EXECUTION

3.1 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 F710.
   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, but not less than 5 or more than 9 pH.
   4. Moisture Testing: Perform tests so that each test area does not exceed 1000 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 F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

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 materials are the same temperature as 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.

3.2 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 in pattern to match existing.

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 in pattern of colors and sizes to match existing.

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 installation 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 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.

I. Floor Polish: Remove soil, adhesive, and blemishes from floor tile surfaces before applying liquid floor polish.
   1. Apply three coat(s).

END OF SECTION 096519

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Primers.
   2. Water-based finish coatings.
   3. Dry fall coatings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of topcoat product.

C. Product Schedule: Use same designations indicated on Drawings and in the Interior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Benjamin Moore & Co.
   2. Dulux Canada; a licensed product of PPG Architectural Coatings.
   3. Sherwin-Williams Company (The).

2.2 PAINT PRODUCTS, GENERAL

A. Material Compatibility:
   1. Materials for use within each paint system shall be 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, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

B. VOC Content: For field applications that are inside the weatherproofing system, verify paints and coatings comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
   1. Flat Paints and Coatings: 50 g/L.
   2. Nonflat Paints and Coatings: 150 g/L.
   3. Dry-Fog Coatings: 400 g/L.
   4. Primers, Sealers, and Undercoaters: 200 g/L.
   5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
   6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
   7. Pretreatment Wash Primers: 420 g/L.
   8. Shellacs, Clear: 730 g/L.
   9. Shellacs, Pigmented: 550 g/L.

C. Low-Emitting Materials: Verify interior paints and coatings comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Colors: Match Architect's samples. Match existing.
   1. Twenty percent of surface area will be painted with deep tones.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

B. 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 applicable to substrates and paint systems 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.

C. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

3.3 INSTALLATION

A. Apply paints according to manufacturer's written instructions.

B. 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.

C. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
   1. Paint the following work where exposed in equipment rooms:
      a. Equipment, including panelboards.
      b. Uninsulated metal piping.
      c. Uninsulated plastic piping.
      d. Pipe hangers and supports.
      e. Metal conduit.
      f. Plastic conduit.
      g. Tanks that do not have factory-applied final finishes.
      h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
   2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 CLEANING AND PROTECTION

A. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

B. 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.

C. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 INTERIOR PAINTING SCHEDULE

A. CMU Substrates:
   1. Latex System:
      a. Block Filler: Interior/exterior latex block filler.
      b. Intermediate Coat: Matching topcoat.
      c. Topcoat: Interior, latex, eggshell.

B. Steel Substrates:
   1. Latex System, Alkyd Primer:
      a. Prime Coat: Alkyd quick-dry primer for metal.
      b. Intermediate Coat: Matching topcoat.
      c. Topcoat: Interior, latex, semigloss.

2. Latex over Shop-Applied Quick-Drying Shop Primer System:
    a. Prime Coat: Quick-dry primer for shop application.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, latex, semigloss.

C. Galvanized-Metal Substrates:
1. Latex System Insert drawing designation:
    a. Prime Coat: Water-based galvanized primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, latex, semigloss.

D. Gypsum Board and Plaster Substrates:
1. Latex over Latex Sealer System:
    a. Prime Coat: Interior latex primer sealer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, latex, eggshell.
2. Latex over Alkyd Primer System (for Plaster Only):
    a. Prime Coat: Interior alkyd primer sealer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, latex, eggshell.

E. Cotton or Canvas and ASJ Insulation-Covering Substrates: Including pipe and duct coverings.
1. Latex System:
    a. Prime Coat: Interior latex primer sealer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, latex, flat.

END OF SECTION 099123

SECTION 123216 - MANUFACTURED PLASTIC-LAMINATE-CLAD CASEWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Plastic-laminate-clad casework.
   2. Hardware and accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For plastic-laminate-clad casework.

C. Samples: For casework and hardware finishes.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of casework that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CASEWORK

A. Quality Standard: Unless otherwise indicated, comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards" for grades of casework indicated for construction, finishes, installation, and other requirements.
   1. Grade: Premium.

B. Product Designations:
   1. Drawings indicate sizes, configurations, and finish materials of manufactured plastic-laminate-clad casework by referencing designated manufacturer's catalog numbers. Other manufacturers' casework of similar sizes and door and drawer configurations, of same finish materials, and complying with the Specifications may be considered. See Section 016000 "Product Requirements."

2. Drawings indicate configurations of manufactured plastic-laminate-clad casework by referencing designations of Casework Design Series numbering system in the Appendix of the AWI/AWMAC/WI's "Architectural Woodwork Standards."

2.2 PLASTIC-LAMINATED-FACED CABINETS

A. Design: Frameless cabinet construction with the following door and drawer-front style:
   1. Flush overlay.

B. Grain Direction for Wood-Grain Plastic Laminate:
   1. Doors: Vertical with continuous vertical matching.
   2. Drawer Fronts: Vertical with continuous vertical matching.
   3. Face Frame Members: Lengthwise.
   4. End Panels: Vertical.
   5. Bottoms and Tops of Units: Side to side.
   6. Knee Space Panels: Vertical.
   7. Aprons: Horizontal.

C. Exposed Materials:
   1. Plastic-Laminate Grade: HGS.
      a. Colors and Patterns: As selected by Architect from manufacturer's full range.
   2. Edgebanding: PVC.
      a. PVC Edgebanding Color: As selected by Architect from casework manufacturer's full range.

D. Semiexposed Materials:
   1. Plastic Laminate: Grade VGS unless otherwise indicated. Provide plastic laminate for semiexposed surfaces unless otherwise indicated.
      a. Colors and Patterns: As selected by Architect from manufacturer's full range.
      b. Provide plastic laminate of same grade as exposed surfaces for interior faces of doors and drawer fronts and other locations where opposite side of component is exposed.
   2. Thermally Fused Laminate (TFL) Panels: Provide thermally fused laminate panels for semiexposed surfaces unless otherwise indicated.
      a. Colors and Patterns: As selected by Architect from manufacturer's full range.
      b. Provide plastic laminate of same grade as exposed surfaces for interior faces of doors and drawer fronts and other locations where opposite side of component is exposed.
   3. Hardboard: Use only for cabinet backs where exterior side of back is not exposed.
   4. Metal for Steel Drawer Pans: Cold-rolled, carbon-steel sheet complying with ASTM A1008/A1008M; matte finish; suitable for exposed applications.
   5. Unless otherwise indicated, provide specified edgebanding on all semiexposed edges.

E. Concealed Materials:
   1. Plywood: Hardwood plywood.
   2. Plastic Laminate: Grade VGS.
   3. Particleboard.
   4. MDF.

2.3 MATERIALS

A. Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.

B. Hardwood Plywood: HPVA HP-1, particleboard core except where veneer core is indicated.

C. Softwood Plywood: DOC PS 1.

D. Particleboard: ANSI A208.1, Grade M-2.

E. MDF: Medium-density fiberboard, ANSI A208.2, Grade 130.

F. Plastic Laminate: High-pressure decorative laminate complying with ISO 4586-3.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Formica Corporation.
      b. Nevamar Company, LLC.
      c. Pionite; a Panolam Industries International, Inc. brand.
      d. Wilsonart LLC.

G. PVC Edgebanding for Plastic Laminate: Rigid PVC extrusions, through color with satin finish, 3.0 mm thick at doors and drawer fronts, 1.0 mm thick elsewhere.

H. Thermally Fused Laminate (TFL) Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper.
   1. Edgebanding for Thermally Fused Laminate (TFL) Panels: PVC or polyester edgebanding matching thermally fused laminate panels.

2.4 HARDWARE AND ACCESSORIES

A. Hardware, General: Unless otherwise indicated, provide manufacturer's standard satin-finish, commercial-quality, heavy-duty hardware.
   1. Use threaded metal or plastic inserts with machine screws for fastening to particleboard except where hardware is through-bolted from back side.

B. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, Type B01602, self-closing.

C. Door and Drawer Bumpers: Self-adhering, clear silicone rubber.

D. Drawer Slides: Manufacturer's standard; complying with ANSI/BHMA A156.9.

E. Adjustable Shelf Supports:
   1. Adjustable Shelf Supports: Pin-type, two-pin-locking plastic shelf rests complying with ANSI/BHMA A156.9, Type B04013.
   2. Adjustable Shelf Supports: Mortise-type, zinc-plated steel standards and shelf rests complying with ANSI/BHMA A156.9, Type B04071 and Type B04091.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Grade: Install casework to comply with same quality standard grade as item to be installed.

B. Install casework level, plumb, and true in line; shim as required using concealed shims. Where casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.

C. Base Cabinets: Set cabinets straight, level, and plumb. Adjust subtops within 1/16 inch of a single plane. Align similar adjoining doors and drawers to a tolerance of 1/16 inch. Bolt adjacent cabinets together with joints flush, tight, and uniform.

D. Wall Cabinets: Hang cabinets straight, level, and plumb. Adjust fronts and bottoms within 1/16 inch of a single plane. Fasten cabinets to hanging strips, masonry, framing, wood blocking, or reinforcements in walls and partitions. Align similar adjoining doors to a tolerance of 1/16 inch.

E. Fasten casework to adjacent units and to masonry, framing, wood blocking, or reinforcements in walls and partitions to comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards."

F. Install hardware uniformly and precisely. Set hinges snug and flat in mortises unless otherwise indicated. Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final adjustment after installation.

G. Adjust operating hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

H. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

END OF SECTION 123216

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sleeves.
   2. Sleeve-seal systems.
   3. Grout.
   4. Silicone sealants.

B. Related Requirements:
   1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.

B. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, anti-corrosion coated or zinc coated, with plain ends and integral welded waterstop collar.

C. Galvanized-Steel Sheet Pipe Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

D. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.

2.2 SLEEVE-SEAL SYSTEMS

A. Description:
   1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   2. Designed to form a hydrostatic seal of 20-psig.
   3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.

4. Pressure Plates: Stainless steel.
5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Description: Nonshrink, recommended for interior and exterior sealing openings in nonfire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, use NT.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Dow Corning Corporation.
      b. GE Construction Sealants; Momentive Performance Materials Inc.
      c. Pecora Corporation.

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.

C. 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 silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.

D. 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 sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 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.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

3.4 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: Sleeve-seal fittings.
      b. Piping NPS 6 and Larger: Sleeve-seal fittings.
   2. Concrete Slabs-on-Grade:
      a. Piping Smaller Than NPS 6: Sleeve-seal fittings.
         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: Sleeve-seal fittings.
   3. 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

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Escutcheons.
   2. Floor plates.

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.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for 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 polished, chrome-plated 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 polished, chrome-plated finish.
k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.

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.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 230518

SECTION 230523.12 - BALL VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Brass ball valves.
   2. Bronze ball valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B1.20.1 for threads for threaded-end valves.
   2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   3. ASME B16.18 for solder-joint connections.
   4. ASME B31.1 for power piping valves.
   5. ASME B31.9 for building services piping valves.

C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

D. Refer to HVAC valve schedule articles for applications of valves.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
   2. Handlever: For quarter-turn valves smaller than NPS 4.

H. Valves in Insulated Piping:
   1. Include 2-inch stem extensions.
   2. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.

3. Memory stops that are fully adjustable after insulation is applied.

I. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

A. Brass Ball Valves, Two-Piece with Full Port and Brass Trim:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Hammond Valve.
b. Legend Valve & Fitting, Inc.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts; a Watts Water Technologies company.
2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.
j. Port: Full.

2.3 BRONZE BALL VALVES

A. Bronze Ball Valves, Two-Piece with Full Port and Bronze or Brass Trim:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Hammond Valve.
b. Legend Valve & Fitting, Inc.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts; a Watts Water Technologies company.
2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Bronze.
i. Ball: Chrome-plated brass.
j. Port: Full.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

3.2 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

B. Select valves with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
   2. For Steel Piping, NPS 2 and Smaller: Threaded ends.

3.3 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: Two piece, full port, brass with brass trim.
   1. Valves may be provided with solder-joint ends instead of threaded ends.

B. Pipe NPS 2 and Smaller: Two piece, full port, bronze with brass or bronze trim.
   1. Valves may be provided with solder-joint ends instead of threaded ends.

3.4 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: Two piece, full port, brass with brass trim.
   1. Valves may be provided with solder-joint ends instead of threaded ends.

B. Pipe NPS 2 and Smaller: Two piece, full port, bronze with brass or bronze trim.
   1. Valves may be provided with solder-joint ends instead of threaded ends.

END OF SECTION 230523.12

SECTION 230523.14 - CHECK VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Bronze swing check valves.
   2. Iron swing check valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B1.20.1 for threads for threaded-end valves.
   2. ASME B16.1 for flanges on iron valves.
   3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   4. ASME B16.18 for solder joint.
   5. ASME B31.1 for power piping valves.
   6. ASME B31.9 for building services piping valves.

C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Bronze Disc, Class 150:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Crane; Crane Energy Flow Solutions.

b. Milwaukee Valve Company.
c. NIBCO INC.

2. Description:
a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

2.3 IRON SWING CHECK VALVES

A. Iron Swing Check Valves with Metal Seats, Class 125:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Crane; Crane Energy Flow Solutions.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts; a Watts Water Technologies company.
2. Description:
a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.

2.4 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Iron Swing Check Valves with Lever- and Spring-Closure Control, Class 125:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Crane; Crane Energy Flow Solutions.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts; a Watts Water Technologies company.
2. Description:
a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.

g. Trim: Bronze.
h. Gasket: Asbestos free.
i. Closure Control: Factory-installed, exterior lever and spring.

B. Iron Swing Check Valves with Lever and Weight-Closure Control, Class 125:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Crane; Crane Energy Flow Solutions.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts; a Watts Water Technologies company.
2. Description:
a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.
i. Closure Control: Factory-installed, exterior lever and weight.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install swing check valves for proper direction of flow in horizontal position with hinge pin level.

3.2 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Pump-Discharge Check Valves:
      a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
      b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring; metal-seat check valves.

B. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.
   3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
   4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
   5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.
   6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.4 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Bronze Swing Check Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 to 4:
   1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
   2. Iron Swing Check Valves: Class 125, metal seats.

C. Pipe NPS 5 and larger:
   1. Iron Swing Check Valves with Closure Control: Class 125, lever and spring or weight.

END OF SECTION 230523.14

SECTION 230548.13 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe-riser resilient supports.
   2. Resilient pipe guides.
   3. Elastomeric hangers.
   4. Spring hangers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PIPE-RISER RESILIENT SUPPORT

A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch-thick neoprene.
   1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
   2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.2 RESILIENT PIPE GUIDES

A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-thick neoprene.
   1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.3 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Ace Mountings Co., Inc.
      b. California Dynamics Corporation.
      c. Isolation Technology, Inc.
      d. Kinetics Noise Control, Inc.
      e. Mason Industries, Inc.
      f. Novia; A Division of C&P.
      g. Vibration Eliminator Co., Inc.

h. Vibration Mountings & Controls, Inc.

2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.4 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Ace Mountings Co., Inc.
      b. California Dynamics Corporation.
      c. Kinetics Noise Control, Inc.
      d. Mason Industries, Inc.
      e. Novia; A Division of C&P.
      f. Vibration Eliminator Co., Inc.
      g. Vibration Isolation.
      h. Vibration Mountings & Controls, Inc.
   2. 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.
   3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
   8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
   9. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 - EXECUTION

3.1 VIBRATION CONTROL DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting.

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

END OF SECTION 230548.13

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Duct labels.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sample text for each equipment identification label clearing showing information to be included on the label. Refer to equipment label requirements below.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
   4. Fasteners: Stainless-steel rivets or self-tapping screws.
   5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
   6. Label Content: Label to include, Equipment ID from drawings (verify with owner) i.e. AHU-101, Manufacturer name, unit serial number, installation date i.e. xx/xx/xxxx format, and performance information (natural gas input/output, supply fan cfm and static pressure at a minimum).

B. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.
   2. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   4. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger

lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

5. Fasteners: Stainless-steel rivets or self-tapping screws.
6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
7. Label Content: Label to include, Equipment ID from drawings (verify with owner) i.e. AHU-101, Manufacturer name, unit serial number, installation date i.e. xx/xx/xxxx format, and performance information (natural gas input/output, supply fan cfm and static pressure at a minimum).

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.

B. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

D. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

E. Fasteners: Stainless-steel rivets or self-tapping screws.

F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

G. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.4 VALVE TAGS

A. Provide 1.5” round brass valve tags indicating valve number.

B. Include valve tag schedule in close out documents.

2.5 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.

B. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

D. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

E. Fasteners: Stainless-steel rivets or self-tapping screws.

F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

G. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

C. Locate labels adjacent to manufacturer label where possible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Section 099123 "Painting."

B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:
   1. Heating Water Piping: Black letters on a safety-orange background.
   2. Refrigerant Piping: White letters on a safety-purple background.
   3. Geothermal loop: Black letters on blue background.

3.4 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
   1. Blue: For outside, return, and relief air ducts.
   2. Yellow: For supply ducts.
   3. Green: For exhaust air ducts.

B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

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. Perform a pre-construction inspection and measurement of the existing primary heating boilers and distribution pumps to document existing system flowrates and to identify any deficiencies. Submit pre-construction Inspection and Measurement Report.

B. At the completion of work, the entire heating hydronic system shall be inspected and balanced.

C. Section Includes:
   1. Balancing Air Systems:
      a. Variable-air-volume systems.
   2. Balancing Hydronic Piping Systems:
      a. Constant-flow hydronic systems.
      b. Variable-flow hydronic systems.
      c. Primary-secondary hydronic systems.
   3. Testing, Adjusting, and Balancing Equipment:
      a. Heat-transfer coils.
   4. Testing, adjusting, and balancing existing systems and equipment that is to remain and be reused.
   5. Control system verification.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. BAS: Building automation systems.

C. NEBB: National Environmental Balancing Bureau.

D. TAB: Testing, adjusting, and balancing.

E. TABB: Testing, Adjusting, and Balancing Bureau.

F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

G. TDH: Total dynamic head.

1.4 PREINSTALLATION MEETINGS

A. TAB Conference: If requested by the Owner, conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
   1. Minimum Agenda Items:
      a. The Contract Documents examination report.
      b. The TAB plan.
      c. Needs for coordination and cooperation of trades and subcontractors.
      d. Proposed procedures for documentation and communication flow.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. System Readiness Checklists: Within 60 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

1.6 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by NEBB or TABB.
   1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
   2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB as a TAB technician.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.7 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:
1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
1. Airside:
a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
b. Duct systems are complete with terminals installed.

c. Volume, smoke, and fire dampers are open and functional.
d. Clean filters are installed.
e. Fans are operating, free of vibration, and rotating in correct direction.
f. Variable-frequency controllers' startup is complete and safeties are verified.
g. Automatic temperature-control systems are operational.
h. Ceilings are installed.
i. Windows and doors are installed.
j. Suitable access to balancing devices and equipment is provided.

2. Hydronics:
   a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
   b. Piping is complete with terminals installed.
   c. Water treatment is complete.
   d. Systems are flushed, filled, and air purged.
   e. Strainers are pulled and cleaned.
   f. Control valves are functioning per the sequence of operation.
   g. Shutoff and balance valves have been verified to be 100 percent open.
   h. Pumps are started and proper rotation is verified.
   i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
   j. Variable-frequency controllers' startup is complete and safeties are verified.
   k. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
   2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
   3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:
   1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
   2. Verify that the system is under static pressure control.
   3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
   4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
      a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
      b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.

c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
d. Adjust controls so that terminal is calling for minimum airflow.
e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.
g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.

5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
   a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
   b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
   c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
   d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
   e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
6. Measure fan static pressures as follows:
   a. Measure static pressure directly at the fan outlet or through the flexible connection.
   b. Measure static pressure directly at the fan inlet or through the flexible connection.
   c. Measure static pressure across each component that makes up the air-handling system.
   d. Report any artificial loading of filters at the time static pressures are measured.
7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
   a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
   b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:
   a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
   b. Re-measure and confirm that total airflow is within design.

c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
d. Mark final settings.
e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
f. Verify tracking between supply and return fans.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
1. Check liquid level in expansion tank.
2. Check highest vent for adequate pressure.
3. Check flow-control valves for proper position.
4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
5. Verify that motor starters are equipped with properly sized thermal protection.
6. Check that air has been purged from the system.

3.7 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Adjust pumps to deliver total design gpm.
1. Measure total water flow.
a. Position valves for full flow through coils.
b. Measure flow by main flow meter, if installed.
c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
2. Measure pump TDH as follows:
a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
c. Convert pressure to head and correct for differences in gage heights.
d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

B. Adjust flow-measuring devices installed in mains and branches to design water flows.
1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.

3. Re-measure each main and branch after all have been adjusted.

C. Adjust flow-measuring devices installed at terminals for each space to design water flows.
   1. Measure flow at terminals.
   2. Adjust each terminal to design flow.
   3. Re-measure each terminal after it is adjusted.
   4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
   5. Perform temperature tests after flows have been balanced.

D. For systems with pressure-independent valves at terminals:
   1. Measure differential pressure and verify that it is within manufacturer's specified range.
   2. Perform temperature tests after flows have been verified.

E. For systems without pressure-independent valves or flow-measuring devices at terminals:
   1. Measure and balance coils by either coil pressure drop or temperature method.
   2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

F. Verify final system conditions as follows:
   1. Re-measure and confirm that total water flow is within design.
   2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
   3. Mark final settings.

G. Verify that memory stops have been set.

3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:
   1. Verify that the differential-pressure sensor is located as indicated.
   2. Determine whether there is diversity in the system.

C. For systems with no diversity:
   1. Adjust pumps to deliver total design gpm.
      a. Measure total water flow.
         1) Position valves for full flow through coils.
         2) Measure flow by main flow meter, if installed.
         3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
      b. Measure pump TDH as follows:
         1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.

2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
3) Convert pressure to head and correct for differences in gage heights.
4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

2. Adjust flow-measuring devices installed in mains and branches to design water flows.
   a. Measure flow in main and branch pipes.
   b. Adjust main and branch balance valves for design flow.
   c. Re-measure each main and branch after all have been adjusted.
3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
   a. Measure flow at terminals.
   b. Adjust each terminal to design flow.
   c. Re-measure each terminal after it is adjusted.
   d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
   e. Perform temperature tests after flows have been balanced.
4. For systems with pressure-independent valves at terminals:
   a. Measure differential pressure and verify that it is within manufacturer's specified range.
   b. Perform temperature tests after flows have been verified.
5. For systems without pressure-independent valves or flow-measuring devices at terminals:
   a. Measure and balance coils by either coil pressure drop or temperature method.
   b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
6. Prior to verifying final system conditions, determine the system differential-pressure set point.
7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
8. Mark final settings and verify that all memory stops have been set.
9. Verify final system conditions as follows:
   a. Re-measure and confirm that total water flow is within design.
   b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
   c. Mark final settings.
10. Verify that memory stops have been set.

D. For systems with diversity:
   1. Determine diversity factor.

2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
3. Adjust pumps to deliver total design gpm.
    a. Measure total water flow.
        1) Position valves for full flow through coils.
        2) Measure flow by main flow meter, if installed.
        3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
    b. Measure pump TDH as follows:
        1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
        2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
        3) Convert pressure to head and correct for differences in gage heights.
        4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
        5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
    c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
4. Adjust flow-measuring devices installed in mains and branches to design water flows.
    a. Measure flow in main and branch pipes.
    b. Adjust main and branch balance valves for design flow.
    c. Re-measure each main and branch after all have been adjusted.
5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
    a. Measure flow at terminals.
    b. Adjust each terminal to design flow.
    c. Re-measure each terminal after it is adjusted.
    d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
    e. Perform temperature tests after flows have been balanced.
6. For systems with pressure-independent valves at terminals:
    a. Measure differential pressure, and verify that it is within manufacturer's specified range.
    b. Perform temperature tests after flows have been verified.
7. For systems without pressure-independent valves or flow-measuring devices at terminals:
    a. Measure and balance coils by either coil pressure drop or temperature method.
    b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system differential-pressure set point.

10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:
    a. Re-measure and confirm that total water flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
    c. Mark final settings.
13. Verify that memory stops have been set.

3.9 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first.

B. Balance the secondary circuits after the primary circuits are complete.

C. Adjust pumps to deliver total design gpm.
1. Measure total water flow.
    a. Position valves for full flow through coils.
    b. Measure flow by main flow meter, if installed.
    c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
2. Measure pump TDH as follows:
    a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    c. Convert pressure to head and correct for differences in gage heights.
    d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
    e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

D. Adjust flow-measuring devices installed in mains and branches to design water flows.
1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

E. Adjust flow-measuring devices installed at terminals for each space to design water flows.
1. Measure flow at terminals.
2. Adjust each terminal to design flow.
3. Re-measure each terminal after it is adjusted.

4. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
5. Perform temperature tests after flows have been balanced.

F. For systems with pressure-independent valves at terminals:
1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

G. For systems without pressure-independent valves or flow-measuring devices at terminals:
1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

H. Verify final system conditions as follows:
1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

I. Verify that memory stops have been set.

3.10 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:
1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.

B. Measure, adjust, and record the following data for each electric heating coil:
1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:
1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:
1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.

3. Airflow.
4. Include horizontal-vertical-axial measurements for tests.
5. Verify that vibration limits follow Specifications, or, if not specified, follow the General Machinery Vibration Severity Chart or Vibration Acceleration General Severity Chart from the AABC National Standards. Acceptable levels of vibration are normally "smooth" to "good."
6. Include in report General Machinery Vibration Severity Chart, with conditions plotted.

3.11 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:
1. Verify temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.12 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
   1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
   2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
   3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
   4. Balance each air outlet.

3.13 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
   2. Air Outlets and Inlets: Plus or minus 10 percent.
   3. Heating-Water Flow Rate: Plus or minus 10 percent.
   4. Cooling-Water Flow Rate: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.14 PROGRESS 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: Prepare monthly progress 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 and each building floor for systems serving multiple floors.

3.15 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.
   3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers' test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:
   1. Title page.
   2. Name and address of the TAB specialist.
   3. Project name.
   4. Project location.
   5. Architect's name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
   8. Report date.
   9. Signature of TAB supervisor who certifies the report.
   10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
   11. Summary of contents including the following:
      a. Indicated versus final performance.
      b. Notable characteristics of systems.
      c. Description of system operation sequence if it varies from the Contract Documents.
   12. Nomenclature sheets for each item of equipment.
   13. Data for terminal units, including manufacturer's name, type, size, and fittings.
   14. Notes to explain why certain final data in the body of reports vary from indicated values.
   15. Test conditions for fans and pump performance forms including the following:
      a. Settings for outdoor-, return-, and exhaust-air dampers.
      b. Conditions of filters.
      c. Cooling coil, wet- and dry-bulb conditions.
      d. Face and bypass damper settings at coils.
      e. Fan drive settings including settings and percentage of maximum pitch diameter.
      f. Inlet vane settings for variable-air-volume systems.
      g. Settings for supply-air, static-pressure controller.
      h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
   1. Quantities of outdoor, supply, return, and exhaust airflows.
   2. Water and steam flow rates.
   3. Duct, outlet, and inlet sizes.
   4. Pipe and valve sizes and locations.
   5. Terminal units.
   6. Balancing stations.
   7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Make and type.
      d. Model number and unit size.
      e. Manufacturer's serial number.
      f. Unit arrangement and class.
      g. Discharge arrangement.
      h. Sheave make, size in inches, and bore.
      i. Center-to-center dimensions of sheave and amount of adjustments in inches.
      j. Number, make, and size of belts.
      k. Number, type, and size of filters.
   2. Motor Data:
      a. Motor make, and frame type and size.
      b. Horsepower and rpm.
      c. Volts, phase, and hertz.
      d. Full-load amperage and service factor.
      e. Sheave make, size in inches, and bore.
      f. Center-to-center dimensions of sheave 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. Preheat-coil static-pressure differential in inches wg.
      g. Cooling-coil static-pressure differential in inches wg.
      h. Heating-coil static-pressure differential in inches wg.
      i. Outdoor airflow in cfm.
      j. Return airflow in cfm.
      k. Outdoor-air damper position.
      l. Return-air damper position.

F. Apparatus-Coil Test Reports:
   1. Coil Data:
      a. System identification.
      b. Location.
      c. Coil type.
      d. Number of rows.
      e. Fin spacing in fins per inch 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. Outdoor-air, wet- and dry-bulb temperatures in deg F.
      e. Return-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. Water flow rate in gpm.
      i. Water pressure differential in feet of head or psig.
      j. Entering-water temperature in deg F.
      k. Leaving-water temperature in deg F.
      l. Refrigerant expansion valve and refrigerant types.
      m. Refrigerant suction pressure in psig.
      n. Refrigerant suction temperature in deg F.
      o. Inlet steam pressure in psig.

G. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
   1. Report Data:
      a. System and air-handling-unit number.
      b. Location and zone.
      c. Traverse air temperature in deg F.
      d. Duct static pressure in inches wg.
      e. Duct size in inches.
      f. Duct area in sq. ft.
      g. Indicated airflow rate in cfm.
      h. Indicated velocity in fpm.
      i. Actual airflow rate in cfm.
      j. Actual average velocity in fpm.
      k. Barometric pressure in psig.

H. Air-Terminal-Device Reports:
   1. Unit Data:
      a. System and air-handling unit identification.
      b. Location and zone.
      c. Apparatus used for test.
      d. Area served.
      e. Make.
      f. Number from system diagram.
      g. Type and model number.
      h. Size.
      i. Effective area in sq. ft.
   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.

I. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Service.
      d. Make and size.
      e. Model number and serial number.
      f. Water flow rate in gpm.
      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.

J. Instrument Calibration Reports:
1. Report Data:
a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.16 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Owner Construction Manager.

B. Architect shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:
1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
3. If the second verification also fails, Owner Architect may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

3.17 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following duct services:
   1. Indoor, supply-air and return-air.

B. Related Sections:
   1. Section 230719 "HVAC Piping Insulation."
   2. Section 233113 "Metal Ducts" for duct liners.

1.2 ACTION SUBMITTALS

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

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
   3. Detail application of field-applied jackets.
   4. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jackets. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. CertainTeed Corporation.
      b. Johns Manville; a Berkshire Hathaway company.
      c. Knauf Insulation.
      d. Owens Corning.

G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. CertainTeed Corporation.
      b. Johns Manville; a Berkshire Hathaway company.
      c. Knauf Insulation.
      d. Owens Corning.

2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
   1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180 deg F.
   3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
   4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180 deg F.
   3. Solids Content: 60 percent by volume and 66 percent by weight.
   4. Color: White.

2.5 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Width: 3 inches.
   2. Thickness: 11.5 mils.
   3. Adhesion: 90 ounces force/inch in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.
   6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Width: 3 inches.
   2. Thickness: 6.5 mils.
   3. Adhesion: 90 ounces force/inch in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.
   6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.6 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020-inch-thick, 3/4-inch-wide with wing seal or closed seal.

B. Insulation Pins and Hangers:
1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030-inch-thick by 2 inches square.
   b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Baseplate: Perforated, nylon sheet, 0.030-inch-thick by 1-1/2 inches in diameter.
   b. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
   c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Baseplate: Galvanized carbon-steel sheet, 0.030-inch-thick by 2 inches square.

b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
c. Adhesive-backed base with a peel-off protective cover.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

L. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

M. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
   1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:
   1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
      b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
      c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
      d. Do not overcompress insulation during installation.
      e. Impale insulation over pins and attach speed washers.
      f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.5 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

3.6 FINISHES

A. Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099123 "Interior Painting."
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless-steel jackets.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each duct system defined in the "Duct Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
1. Indoor, outdoor air.
2. Indoor, concealed or exposed supply, located in unconditioned space.
3. Indoor, exposed supply, when exposed in space not conditioned by the supply duct.
4. Indoor, concealed or exposed return, located in unconditioned space.
5. Indoor, Type II, commercial, kitchen hood exhaust.
6. Indoor, exhaust between isolation damper and penetration of building exterior.
7. Outdoor, supply and return.

B. Items Not Insulated:
1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, Supply-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

B. Concealed, Return-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

END OF SECTION 230713

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following HVAC piping systems:
   1. Heating hot-water piping, indoors and outdoors.

B. Related Sections:
   1. Section 230713 "Duct Insulation."

1.2 ACTION SUBMITTALS

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

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail attachment and covering of heat tracing inside insulation.
   3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   4. Detail application of field-applied jackets.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Pittsburgh Corning Corporation.
   2. Block Insulation: ASTM C 552, Type I.
   3. Special-Shaped Insulation: ASTM C 552, Type III.
   4. Board Insulation: ASTM C 552, Type IV.
   5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
   6. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
   7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Aeroflex USA, Inc.
      b. Armacell LLC.
      c. K-Flex USA.

G. Mineral-Fiber, Preformed Pipe Insulation:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Johns Manville; a Berkshire Hathaway company.
      b. Knauf Insulation.
      c. Owens Corning.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Armacell LLC.
b. Nomaco Insulation.

2.2 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

F. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180 deg F.
   3. Solids Content: 60 percent by volume and 66 percent by weight.
   4. Color: White.

2.5 SEALANTS

A. Joint Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Permanently flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 100 to plus 300 deg F.
   4. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F.
   4. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F.
   4. Color: White.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Johns Manville; a Berkshire Hathaway company.
      b. Speedline Corporation.
   2. Adhesive: As recommended by jacket material manufacturer.
   3. Color: White.
   4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
   1. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
   2. Finish and thickness are indicated in field-applied jacket schedules.
   3. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
   4. Moisture Barrier for Outdoor Applications: 2.5-mil-thick polysurlyn.
   5. Factory-Fabricated Fitting Covers:
      a. Same material, finish, and thickness as jacket.
      b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      c. Tee covers.
      d. Flange and union covers.
      e. End caps.
      f. Beveled collars.
      g. Valve covers.
      h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Width: 3 inches.
   2. Thickness: 11.5 mils.
   3. Adhesion: 90 ounces force/inch in width.
   4. Elongation: 2 percent.

5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Width: 3 inches.
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020-inch-thick, 1/2-inch-wide with wing seal or closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

A. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
   a. For below-ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
   2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of cellular-glass insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of polyolefin pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.10 FINISHES

A. Pipe Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099123 "Interior Painting."
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.12 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Heating-Hot-Water Supply and Return, 200 Deg F and Below: Insulation shall be one of the following:
   1. Cellular Glass: 2 inches thick.
   2. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inches thick.

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:
   1. None.

D. Piping, Exposed:
   1. PVC: 30 mils thick.

END OF SECTION 230719

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.

1.2 SUMMARY

A. Commisioning by owner provided agent. Information in this section is for reference only to indicate coordination required by contractor with the commissioning agent.

B. Section includes Cx process requirements for the following HVAC systems, assemblies, and equipment:
   1. Heat generation systems.
   2. Cooling generation systems.
   3. Central-station air-handling systems.
   4. Air and hydronic distribution systems.
   5. Heating and cooling terminal and unitary equipment.
   6. HVAC controls.
   7. TAB verification.

C. Related Requirements:
   1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
   2. For construction checklists, comply with requirements in various Division 23 Sections specifying HVAC systems, system components, equipment, and products.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."

C. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."

D. IgCC: International Green Construction Code.

E. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they mean "as-built" systems, assemblies, subsystems, equipment, and components.

F. TAB: Testing, adjusting, and balancing.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For BAS and HVAC testing technician.

B. Construction Checklists:
   1. Cx plan, including material, installation, and performance construction checklists for systems, assemblies, subsystems, equipment, and components relating to BAS and HVAC to be part of the Cx process and in accordance with requirements in Section 019113 "General Commissioning Requirements and ASHRAE 202."

C. Test Equipment and Instruments: For all test equipment and instruments to be used in conducting Cx tests by Div. 23 Subcontractor, provide the following:
   1. Equipment/instrument identification number.
   2. Planned Cx application or use.
   3. Manufacturer, make, model, and serial number.
   4. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
   5. Equipment manufacturers' proprietary instrumentation and tools. For each instrument or tool, identify the following:
      a. Instrument or tool identification number.
      b. Equipment schedule designation of equipment for which the instrument or tool is required.
      c. Manufacturer, make, model, and serial number.
      d. Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

1.5 QUALITY ASSURANCE

A. BAS Testing Technician Qualifications: Technicians performing BAS Construction Checklist verification tests, Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations are to have the following minimum qualifications:
   1. Journey level or equivalent skill level with knowledge of BAS, HVAC, electrical concepts, and building operations.
   2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
   3. International Society of Automation (ISA)-Certified Control Systems Technician (CCST) Level I.

B. HVAC Testing Technician Qualifications: Technicians to perform HVAC Construction Checklist verification tests, Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:
   1. Journey level or equivalent skill level; vocational school four-year-program graduate or an Associate's degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC equipment, assemblies, and systems.
   2. Minimum three years' experience that is to include installing, servicing, and operating systems manufactured by approved manufacturer.

C. Testing Equipment and Instrumentation Quality and Calibration:
   1. Capable of testing and measuring performance within the specified acceptance criteria.
   2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
   3. Be maintained in good repair and operating condition throughout duration of use on Project.
   4. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 Cx PROCESS:

A. Perform Cx process in accordance with Section 019113 "General Commissioning Requirements" for BAS and HVAC and in accordance with the following:
   1. Commissioning standards acceptable to the authority having jurisdiction.

3.2 CONSTRUCTION CHECKLISTS

A. Prepare preliminary detailed construction checklists for each BAS and HVAC system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in ASHRAE 202.
   1. Submit preliminary construction checklists to CxA and Designer for review.
   2. When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."
   3. Use only construction checklists, marked "Approved for Use, (date)" when performing tests. Mark construction checklists in the appropriate place, as indicated Project events are completed and provide pertinent details and other information.

B. Additional systems required to be commissioned:
   1. Heat generation systems, including the following:
      a. Boilers.
   2. Cooling generation systems, including the following:
      a. Direct-expansion refrigeration systems.
   3. Air-handling systems, including the following:
      a. Supply, return, and exhaust air fans, motors, and drives.
      b. Automatic and gravity dampers.
      c. Heating and cooling devices.
      d. Humidification and dehumidification devices.
      e. Air filters.
      f. Hangers and supports.
      g. Interlock between air-handling system and fire/smoke alarm system.
   4. Air duct systems, including the following:
      a. Duct systems.
      b. Air-duct accessories, including volume dampers, fire and smoke dampers, turning vanes, sound attenuators, and flexible connectors.
      c. Duct-mounted access doors and panels.
      d. Hangers and supports.
   5. Hydronic distribution systems, including the following:
      a. Hydronic piping systems and all accessories.
      b. Pumps and all accessories.
      c. Sleeves and sleeve seals.
      d. Meters and gauges.
      e. General-duty and specialty valves.
      f. Hangers and supports
   6. Refrigerant piping, including the following:
      a. Refrigerant piping, fittings, and specialties.
      b. Refrigerant charge.
      c. Sleeves and sleeve seals.
      d. Meters and gauges.
      e. General-duty and specialty valves.
      f. Hangers and supports.
   7. Heating and cooling terminal and unitary equipment, including the following:
      a. Unit heaters.
      b. Fan-coil units.
      c. Finned-tube radiation.
      d. Unitary heating and cooling equipment.
   8. Vibration isolation systems.
   9. Controls and instrumentation, including the following:
      a. Energy monitoring and recording system.
      b. Controllers and sensors.
      c. Automatic control valves, dampers, and actuators.
      d. Control interface with fans, pumps, dampers, and other equipment and systems.
      e. Demand-control systems.
   10. TAB Verification:
      a. Airflow.

b. Water flow.
c. Space pressurization.

11. Documentation:
    a. Mechanical systems manuals.
    b. Documentation of required commissioning.
12. Exhaust Air Systems, including the following:
    a. Restroom exhaust.
    b. Electrical room exhaust.
13. Mechanical insulation, including the following:
    a. Duct and plenum insulation.
    b. HVAC piping insulation.

3.3 Cx TESTING PREPARATION

A. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.

B. Certify that HVAC instrumentation and control systems have been completed and calibrated, point-to-point checkout has been successfully completed, and systems are operating in accordance with their design sequence of operation, Contract Documents, and approved submittals. Certify that all sensors are operating within specified accuracy and all systems are set to and maintaining set points as required by the design documents.

C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

3.4 Cx TEST CONDITIONS

A. Perform tests using design conditions, whenever possible.
    1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA, and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
    2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.
    3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

B. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to Architect. After deficiencies are resolved, reschedule tests.

C. If seasonal testing is specified, complete appropriate initial performance tests and documentation, and schedule seasonal tests.

3.5 Cx TESTS COMMON TO HVAC SYSTEMS

A. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.

B. Test systems, assemblies, subsystems, equipment, and components for operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response in accordance with acceptance criteria.

C. Coordinate schedule with, and perform Cx activities at the direction of, CxA.

D. Comply with Construction Checklist requirements, including material verification, installation checks, startup, and performance test requirements specified in Division 23 Sections specifying HVAC systems and equipment.

E. Provide technicians, instrumentation, tools, and equipment to perform and document the following:
   1. Cx Construction Checklist verification tests.
   2. Cx Construction Checklist verification test demonstrations.

3.6 CONSTRUCTION CHECKLIST EXAMPLES

A. Vibration Isolation in HVAC Systems:
   1. Prerequisites: Acceptance of results of construction checklists for vibration control devices specified in Section 230548.13 "Vibration Controls for HVAC Piping and Equipment".
   2. Components to Be Tested:
      a. Vibration isolation control devices in HVAC systems.
      b. Support systems.
   3. Test Purpose: Evaluate effectiveness of vibration isolation control devices.
   4. Test Conditions, Constant Speed Equipment: Measure vibration of the facility structure at three locations designated by Owner's witness while the isolated equipment operates.
   5. Test Conditions, Variable Speed Equipment: Measure vibration of the facility structure at three locations designated by Owner's witness at the following operating conditions:
      a. Maximum speed.
      b. Minimum speed.
      c. Critical speed.
   6. Acceptance Criteria: Structure-borne vibration not to exceed specified performance.

3.7 TAB VERIFICATION

A. Prerequisites: Completion of "Examination" Article requirements and correction of deficiencies, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

B. Completion of "Preparation" Article requirements for preparation of a TAB plan that includes strategies and step-by-step procedures, and system-readiness checks and reports, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

C. Scope: HVAC air systems and hydronic piping systems.

D. Purpose: Differential flow relationships intended to maintain air and water pressurization differentials between the various areas of Project.

E. Conditions of the Test:
   1. Cx Test Demonstration Sampling Rate: As specified in "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
   2. Systems operating in full heating mode with minimum outside-air volume.
   3. Systems operating in full cooling mode with minimum outside-air volume.
   4. For measurements at air-handling units with economizer controls; systems operating in economizer mode with 100 percent outside air.

F. Acceptance Criteria:
   1. Under all conditions, rechecked measurements comply with "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
   2. Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than the tolerances allowed.
   3. Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.

3.8 HEATING CONTROL SYSTEM Cx TESTS

A. Heating-Water Supply Temperature Control:
   1. Prerequisites: Installation verification of the following:
      a. Startup of boiler.
      b. Startup of heating-water pump(s).
      c. TAB of heating-water flow and pressure.
      d. Input Device: Heating-water supply temperature; thermostat thermistor temperature sensor.
      e. Output Device: Control valve.
      f. Display the following at the operator's workstation:
         1) Heating-water supply temperature.
         2) Heating-water supply temperature set point.
         3) Control-valve position.
   2. Scope: Heating-water system.
   3. Purpose: Control of heating-water supply temperature at input device.

4. Conditions of the Test:
   a. Minimum heating-water flow.
   b. Midrange Heating-Water Flow: 50 to 60 percent of maximum.
   c. Maximum heating-water flow.
5. Acceptance Criteria: Under all conditions, heating-water supply temperature is within plus or minus 2.0 deg F of set point.

B. Heating-Water Supply Temperature Reset:
1. Prerequisites: Installation verification of the following:
   a. Startup of boiler.
   b. Startup of heating-water pump(s)
   c. TAB of heating-water flow and pressure.
   d. Input Device: Heating-water supply temperature; thermostat thermistor temperature sensor.
   e. Input Device: Outdoor-air temperature; electric, outdoor-air-reset controller outdoor-air sensor.
   f. Output Device: Control valve.
   g. Display the following at the operator's workstation:
      1) Outdoor-air temperature.
      2) Heating-water supply temperature.
      3) Heating-water supply temperature set point.
      4) Control-valve position.
2. Scope: Heating-water system.
3. Purpose: Control of heating-water supply temperature at heating-water supply temperature input device in response to variable outdoor-air temperature input; outdoor-air sensor.
4. Conditions of the Test: Outdoor-air temperature input value may be overridden for this test.
   a. Low Temperature: Outdoor-air temperature between minus 30 and 0 deg F.
   b. Midrange Temperature: Outdoor-air temperature between 30 and 45 deg F.
   c. High Temperature: Outdoor-air temperature above 65 deg F.
5. Acceptance Criteria: Heating-water supply temperature resets in straight-line relationship with outdoor-air temperature for the following reset schedule. Under all conditions, heating-water supply temperature is within 2.0 deg F of set point.
   a. 195 deg F heating water when outdoor-air temperature is minus 30 deg F.
   b. 130 deg F heating water when outdoor-air temperature is 65 deg F.
   c. Under all conditions, heating-water supply temperature is within plus or minus 2.0 deg F of set point.

C. Control Primary Circulating Pump(s):
1. Prerequisites: Installation verification of the following:
   a. Startup of heating-water pump(s).
   b. Input Device: Outdoor-air temperature; electric, outdoor-air-reset controller outdoor-air sensor.
   c. Output Device: Heating-water pump; DDC system command to starter relay.
   d. Display the following at the operator's workstation:
      1) Outdoor-air temperature.

2) Operating status of primary circulating pump(s).

2. Scope: Heating-water pump(s) and associated controls.
3. Purpose: On-off control of heating-water pump(s) in response to variable outdoor-air temperature input; electric, outdoor-air-reset controller outdoor-air sensor.
4. Conditions of the Test:
   a. High Temperature: Outdoor-air temperature above 65 deg F.
   b. Low Temperature: Outdoor-air temperature below 65 deg F.
5. Acceptance Criteria:
   a. High Temperature: Pump(s) are off when outside-air temperature is above 65 deg F.
   b. Low Temperature: Pump(s) are on when outside-air temperature is below 65 deg F.

3.9 VERTICAL UNIT VENTILATOR EQUIPMENT Cx TESTS

A. VERTICAL UNIT VENTILATOR with Coils:
   1. Prerequisites: Installation verification of the following:
      a. Occupancy Input Device: Occupancy sensor.
      b. Occupancy Output Device: DDC system binary output.
      c. Room Temperature Input Device: Room thermostat.
      d. Room Temperature Output Device: Electronic damper actuators and control-valve operators.
      e. Display the following at the operator's workstation:
         1) Room/area served.
         2) Room occupied/unoccupied.
         3) Room temperature indication.
         4) Room temperature set point.
         5) Room temperature set point, occupied.
         6) Room temperature set point, unoccupied.
         7) Air-damper position as percentage open.
         8) Control-valve position as percentage open.
   2. Scope: Vertical Unit Ventilator with hydronic coils in supply-air systems, and associated controls.
   3. Purpose:
      a. Occupancy-dependent room temperature set-point reset.
      b. Room temperature control.
   4. Conditions of the Test:
      a. Cx Test Demonstration Sampling Rate: 10 percent of each model/size unit.
      b. Temperature Control - Occupied: Start with the room unoccupied. Occupy the room and observe the change to occupied status. Observe temperature control until room temperature is stable at occupied set point, plus or minus 1.0 deg F.
      c. Temperature Control - Unoccupied: Start with the room occupied. Vacate the room and observe the change to unoccupied status. Observe temperature control until room temperature is stable at unoccupied set point, plus or minus 1.0 deg F.

5. Acceptance Criteria:
    a. Temperature Control - Occupied:
        1) Control system status changes from "occupied" to "unoccupied" after the specified time.
        2) Room temperature is stable at occupied set point, plus or minus 1.0 deg F within 10 minutes of occupancy. Room temperature does not overshoot or undershoot set point by more than 2.0 deg F during transition.
    b. Temperature Control - Unoccupied:
        1) Control system status changes from "unoccupied" to "occupied" after five minutes of continuous occupancy.
        2) Room temperature is stable at unoccupied set point, plus or minus 1.0 deg F within 30 minutes of occupancy.

3.10 AIR-HANDLING SYSTEM Cx TESTS

A. Supply Fan(s) Variable-Volume Control:
1. Prerequisites: Installation verification of the following:
    a. Volume-Control Input Device: Differential-pressure switch sensing supply-duct static pressure referenced to conditioned-space static pressure.
    b. Volume-Control Output Device: DDC system analog output to modulating damper actuator. Set inlet guide vanes to closed position when fan is stopped.
    c. Volume-Control Input Device: Differential-pressure switch sensing supply-duct static pressure referenced to conditioned-space static pressure.
    d. Volume-Control Output Device: DDC system analog output to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.
    e. High-Pressure Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to static pressure outside the duct.
2. Scope: supply fan units and associated controls.
3. Purpose:
    a. Supply-air discharge static pressure control.
    b. Response to excess supply-air discharge static pressure condition.
4. Conditions of the Test:
    a. Minimum supply-air flow.
    b. Midrange Supply-Air Flow: 50 to 60 percent of maximum.
    c. Maximum supply-air flow.
    d. Excess supply-air discharge static pressure.
5. Acceptance Criteria:
    a. At all supply-air flow rates, and during changes in supply-air flow, discharge air static pressure is at set point plus or minus 2 percent.
    b. Fan stops and an alarm is initiated at the operator's workstation when supply-air discharge static pressure is at the excess static pressure, plus or minus 2 percent.

B. Air-Handler Mixed-Air Control:
1. Prerequisites: Installation verification of the following:
    a. Minimum Position Input Device: DDC system time schedule.

b. Output Device: DDC system analog output to modulating damper actuator(s).
c. Heating Reset Input Device: Room thermostat.
d. Mixed-Air Temperature Input Device: Duct-mounted thermostat Electronic temperature sensor.
e. Cooling Reset Input Device: Outdoor- and return-air, duct-mounted thermostats.
f. Display the following at the operator's workstation:
1) Mixed-air-temperature indication.
2) Mixed-air-temperature set point.
3) Mixed-air damper position.

2. Scope: Air handler with mixed-air control and associated controls.
3. Purpose:
a. Occupied time control.
b. Minimum damper position control.
c. Heating reset control.
d. Mixed-air temperature control.
e. Cooling reset control.
f. Unoccupied time control.
4. Conditions of the Test:
a. Occupied Time Control: Start in unoccupied schedule. Advance to occupied schedule time.
b. Minimum Damper Position Control: Command system to mode in which minimum damper position is required.
c. Heating Reset Control: Create a call for heating.
d. Mixed-Air Temperature Control: Override mixed-air temperature set point to a value 2.0 deg F above current mixed-air temperature.
e. Cooling Reset Control: Override outdoor-air enthalpy to a value that exceeds return-air enthalpy.
f. Unoccupied Time Control: Advance to unoccupied schedule time.
g. Control Data Trend Log: Set up a data trend log of the following input device values and output device commands. Record data at hourly intervals. Submit trend data for 24-hour periods in which natural conditions require heating reset control, mixed-air temperature control, and cooling reset control.
1) Minimum position input device.
2) Heating reset input device.
3) Mixed-air temperature input device.
4) Cooling reset input device.
5. Acceptance Criteria:
a. Occupied Time Control: Mixed-air control is active in occupied mode.
b. Minimum Damper Position Control: Controller positions outdoor-air dampers to minimum position.
c. Heating Reset Control: Controller sets outdoor-air dampers to minimum position.
d. Mixed-Air Temperature Control: Controller modulates outdoor-, return-, and relief-air dampers to maintain temporary mixed-air temperature set point, plus or minus 1.0 deg F.

e. Cooling Reset Control: Controller sets outdoor-air dampers to minimum position when outdoor-air enthalpy exceeds return-air enthalpy.
f. Unoccupied Time Control: Controller positions outdoor- and relief-air dampers closed and return-air dampers open.
g. Control Data Trend Log: Data verify control in accordance with sequence of control.

END OF SECTION 230800

SECTION 230923.11 - CONTROL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes control valves and actuators for DDC systems.

B. Related Requirements:
1. Section 230923 "Direct-Digital Control System for HVAC" control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 230993.11 "Sequence of Operations for HVAC DDC" for requirements that relate to Section 230923.11.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
1. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal:
1. Schedule and design calculations for control valves and actuators, including the following:
    a. Flow at project design and minimum flow conditions.
    b. Pressure differential drop across valve at project design flow condition.
    c. Design and minimum control valve coefficient with corresponding valve position.
    d. Maximum close-off pressure.
    e. Torque required at worst case condition for sizing actuator.
    f. Actuator selection indicating torque provided.
    g. Actuator signal to control dam (on, close or modulate).
    h. Actuator position on loss of power.
    i. Actuator position on loss of control signal.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.

C. Delegated Design: Engage a qualified professional, as defined in Section 014000 "Quality Requirements," to size products where indicated as delegated design.

D. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.

E. Determine control valve sizes and flow coefficients by ISA 75.01.01.

F. Control valve characteristics and rangeability shall comply with ISA 75.11.01.

G. Selection Criteria:
   1. Control valves shall be suitable for operation at following conditions:
      a. Chilled Water: 150 psi and temperature range from 0 to 100 deg F.
      b. Heating Hot Water: 150 psi and temperature range from 0 to 250 deg F.
   2. Fail positions unless otherwise indicated:
      a. Chilled Water: Close.
      b. Heating Hot Water: Open.
   3. Minimum Cv shall be calculated at 10 percent of design flow, with a coincident pressure differential equal to the system design pump head.
   4. In water systems, select modulating control valves at terminal equipment for a design Cv based on a maximum pressure drop of 3 psig at design flow unless otherwise indicated.

2.2 BALL-STYLE CONTROL VALVES

A. Ball Valves with Single Port and Characterized Disk:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Belimo Aircontrols (USA), Inc.
   2. Pressure Rating for NPS 1 and Smaller: Nominal 600 WOG.
   3. Pressure Rating for NPS 1-1/2 through NPS 2: Nominal 400 WOG.
   4. Close-off Pressure: 200 psig.
   5. Process Temperature Range: Zero to 212 deg F.
   6. Body and Tail Piece: Cast bronze ASTM B 61, ASTM B 62, ASTM B 584, or forged brass with nickel plating.
   7. End Connections: Threaded (NPT) ends.
   8. Ball: Chrome-plated brass or bronze or 300 series stainless steel.
   9. Stem and Stem Extension:
      a. Material to match ball.
      b. Blowout-proof design.
      c. Sleeve or other approved means to allow valve to be opened and closed without damaging the insulation or the vapor barrier seal.
   10. Ball Seats: Reinforced PTFE.

11. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.
12. Flow Characteristic: Equal percentage.

B. Ball Valves with Two Ports and Characterized Disk:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Belimo Aircontrols (USA), Inc.
2. Pressure Rating for NPS 1 and Smaller: Nominal 600 WOG.
3. Pressure Rating for NPS 1-1/2 through NPS 2: Nominal 400 WOG.
4. Close-off Pressure: 200 psig.
5. Process Temperature Range: Zero to 212 deg F.
6. Body and Tail Piece: Cast bronze ASTM B 61, ASTM B 62, ASTM B 584, or forged brass with nickel plating.
7. End Connections: Threaded (NPT) ends.
8. Ball: Chrome-plated brass or bronze or 300 series stainless steel.
9. Stem and Stem Extension:
   a. Material to match ball.
   b. Blowout-proof design.
   c. Sleeve or other approved means to allow valve to be opened and closed without damaging the insulation or the vapor barrier seal.
10. Ball Seats: Reinforced PTFE.
11. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.
12. Flow Characteristics for A-Port: Equal percentage.
13. Flow Characteristics for B-Port: Modified for constant common port flow.

C. Pressure-Independent Ball Valves NPS 2 and Smaller:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Belimo Aircontrols (USA), Inc.
2. Performance:
   a. Pressure Rating: 600 psig for NPS 1 and 400 psig for NPS 1-1/2 and NPS 2.
   b. Close-off pressure of 200 psig.
   c. Process Temperature Range: Between zero to 212 deg F.
   d. Rangeability: 100 to 1.
3. Integral Pressure Regulator: Located upstream of ball to regulate pressure, to maintain a constant pressure differential while operating within a pressure differential range of 5 to 50 psig.
4. Body: Forged brass, nickel plated, and with threaded ends.
5. Ball: Chrome-plated brass.
6. Stem and Stem Extension: Chrome-plated brass, blowout-proof design.

7. Stem sleeve or other approved means to allow valve to be opened and closed without damaging field-applied insulation and insulation vapor barrier seal.
8. Ball Seats: Reinforced PTFE.
9. Stem Seal: Reinforced PTFE packing ring stem seal with threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if equivalent cycle endurance can be achieved.
10. Flow Characteristic: Equal percentage.

2.3 SOLENOID VALVES

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. ASCO Valve, Inc.

B. Description:
   1. Action: Either normally open or normally closed in the event of electrical power failure as required by the application.
   2. Size to close against the system pressure.
   3. Manual override capable.
   4. Heavy-duty assembly.
   5. Body: Brass or stainless steel.
   6. Seats and Discs: NBR or PTFE.
   7. Solenoid Enclosure: NEMA 250, Type 4.

2.4 ELECTRIC AND ELECTRONIC CONTROL VALVE ACTUATORS

A. Actuators for Hydronic Control Valves: Capable of closing valve against system pump shutoff head.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
      a. Belimo Aircontrols (USA), Inc.

B. Position indicator and graduated scale on each actuator.

C. Type: Motor operated, with or without gears, electric and electronic.

D. Voltage: Voltage selection delegated to professional designing control system.

E. Deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.

F. Function properly within a range of 85 to 120 percent of nameplate voltage.

G. Construction:
   1. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.

2. For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.
3. For Actuators Larger Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

H. Field Adjustment:
1. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.
2. Gear Type Actuators: External manual adjustment mechanism to allow manual positioning when the actuator is not powered.

I. Two-Position Actuators: Single direction, spring return or reversing type.

J. Modulating Actuators:
1. Operation: Capable of stopping at all points across full range, and starting in either direction from any point in range.
2. Control Input Signal:
   a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position and other input drives actuator to close position. No signal of either input remains in last position.
   b. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10-V dc or 4- to 20-mA signals.
   c. Pulse Width Modulation (PWM): Actuator drives to a specified position according to pulse duration (length) of signal from a dry contact closure, triac sink, or source controller.
   d. Programmable Multi-Function:
      1) Control Input, Position Feedback, and Running Time: Factory or field programmable.
      2) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
      3) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.

K. Position Feedback:
1. Equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.
2. Equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.
3. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

L. Fail-Safe:
1. Where indicated, provide actuator to fail to an end position.
2. Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.

3. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

M. Integral Overload Protection:
1. Provide against overload throughout the entire operating range in both directions.
2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

N. Valve Attachment:
1. Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to valve shaft without the need for connecting linkages.
2. Attach actuator to valve drive shaft in a way that ensures maximum transfer of power and torque without slippage.
3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

O. Temperature and Humidity:
1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F.
2. Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from 5 to 95 percent relative humidity, non-condensing.

P. Enclosure:
1. Suitable for ambient conditions encountered by application.
2. NEMA 250, Type 2 for indoor and protected applications.
3. NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.
4. Provide actuator enclosure with heater and control where required by application.

Q. Stroke Time:
1. Operate valve from fully closed to fully open within 90 seconds.
2. Operate valve from fully open to fully closed within 90 seconds.
3. Move valve to failed position within 30 seconds.
4. Select operating speed to be compatible with equipment and system operation.

R. Sound:
1. Spring Return: 62 dBA.
2. Non-Spring Return: 45 dBA.

PART 3 - EXECUTION

3.1 CONTROL VALVE APPLICATIONS

A. Control Valves:
1. Select from valves specified in "Control Valves" Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.

3.2 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy most stringent requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Properly support instruments, tubing, piping, wiring, and conduits to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a force.

D. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

E. Firestop penetrations made in fire-rated assemblies and seal penetrations made in acoustically rated assemblies.

F. Fastening Hardware:
   1. Stillson wrenches, pliers, and other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
   2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
   3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

G. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

H. Corrosive Environments:
   1. Use products that are suitable for environment to which they will be subjected.
   2. If possible, avoid or limit use of materials in corrosive environments, including. but not limited to, the following:
      a. Laboratory exhaust airstreams.
      b. Process exhaust airstreams.
   3. Use Type 316 stainless-steel tubing and fittings when in contact with a corrosive environment.
   4. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
   5. Where control devices are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.3 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 CONTROL VALVES

A. Install pipe reducers for valves smaller than line size. Position reducers as close to valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.

B. Install flanges or unions to allow drop-in and -out valve installation.

C. Where indicated, install control valve with three-valve bypass manifold to allow for control valve isolation and removal without interrupting system flow by providing manual throttling valve in bypass pipe.

D. Install drain valves in piping upstream and downstream of each control valve installed in a three-valve manifold and for each control valve larger than NPS 2.

E. Install pressure temperature taps in piping upstream and downstream of each control valve larger than NPS 1.

F. Valve Orientation:
   1. Where possible, install globe and ball valves installed in horizontal piping with stems upright and not more than 15 degrees off of vertical, not inverted.
   2. Install valves in a position to allow full stem movement.
   3. Where possible, install butterfly valves that are installed in horizontal piping with stems in horizontal position and with low point of disc opening with direction of flow.

G. Clearance:
   1. Locate valves for easy access and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.
   2. Install valves with at least 12 inches of clear space around valve and between valves and adjacent surfaces.

H. Threaded Valves:
   1. Note internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
   2. Align threads at point of assembly.

3. Apply thread compound to external pipe threads, except where dry seal threading is specified.
4. Assemble joint, wrench tight. Apply wrench on valve end as pipe is being threaded.

I. Flanged Valves:
1. Align flange surfaces parallel.
2. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

J. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

K. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

L. Install engraved phenolic nameplate with valve identification on valve.

3.5 CHECKOUT PROCEDURES

A. Control Valve Checkout:
1. Check installed products before continuity tests, leak tests, and calibration.
2. Check valves for proper location and accessibility.
3. Check valves for proper installation for direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
4. Verify that control valves are installed correctly for flow direction.
5. Verify that valve body attachment is properly secured and sealed.
6. Verify that valve actuator and linkage attachment are secure.
7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
8. Verify that valve ball, disc, and plug travel are unobstructed.
9. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

3.6 ADJUSTMENT, CALIBRATION, AND TESTING

A. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.

C. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

D. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION 230923.11

SECTION 230993.11 - SEQUENCE OF OPERATIONS FOR HVAC DDC

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 control sequences for DDC for HVAC systems, subsystems, and equipment.

B. Related Requirements:
   1. Section 230923 "DDC Systems for HVAC" for control equipment.
   2. Sequences included herein are general in nature, refer to control drawing for specific equipment sequences.

1.3 DEFINITIONS

A. Analog Output: Proportional output signal (zero- to 10-V dc, 4 to 20 mA).

B. Binary Output: On/off output signal or contact closure.

C. DDC: Direct digital control.

D. Digital Output: Data output that must be interpreted digitally.

1.4 ACTION SUBMITTALS

A. Product Data:
   1. An instrumentation list for each controlled system. Label each element of the controlled system in table format. Show, in the table element name, type of device, manufacturer, model number, and control device product data sheet number.
   2. A complete description of the operation of the control system, including sequences of operation. Include and reference a schematic diagram of the controlled system.

B. Shop Drawings:
   1. Riser diagrams showing control network layout, communication protocol, and wire types.

2. Schematic diagram of each controlled system. Include all control points labeled with point names shown or listed. Show the location of control elements in the system.
3. Wiring diagram for each controlled system. Show all control elements labels. Where a control element is the same as that shown on the control system schematic, label with the same name. Label all terminals.

1.5 HVAC CONTROL SEQUENCES

A. Refer to controls sequence on associated drawings.

B. Coordination of HVAC Sequences: Ensure that preheat, mixed-air, heating-coil, and cooling-coil controls have common inputs and do not overlap in function.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230993.11

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:
   1. Steel pipe and fittings.
   2. Copper pipe and fittings.
   3. Joining materials.
   4. Dielectric fittings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Pipe.
   2. Fittings.
   3. Joining materials.

B. Delegated-Design Submittal:
   1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
   2. Locations of pipe anchors and alignment guides and expansion joints and loops.

1.3 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
   1. Hot-Water Heating Piping: 125 psig at 200 deg F.
   2. Makeup-Water Piping: 80 psig at 150 deg F.
   3. Air-Vent Piping: 200 deg F.
   4. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. DWV Copper Tubing: ASTM B 306, Type DWV.

D. Grooved, Mechanical-Joint, Wrought-Copper Fittings: ASME B16.22.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
      a. Anvil International.
      b. Victaulic Company.
   2. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
   3. Grooved-End-Tube Couplings: Rigid pattern unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, prelubricated EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.

E. Wrought-Copper Unions: ASME B16.22.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.

F. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   1. Material Group: 1.1.
   2. End Connections: Butt welding.
   3. Facings: Raised face.

G. Grooved Mechanical-Joint Fittings and Couplings:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Anvil International.
      b. Victaulic Company.

2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106/A 106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
3. Couplings: Ductile- or malleable-iron housing and EPDM gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

2.4 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Watts; a Watts Water Technologies company.
      b. Wilkins.
      c. Zurn Industries, LLC.
   2. Description:
      a. Standard: ASSE 1079.
      b. Pressure Rating: 125 psig minimum at 180 deg F.
      c. End Connections: Solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.

B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
   2. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

C. Hot-Water Heating Piping Installed Belowground: Type K, annealed-temper copper tubing, wrought-copper fittings, and brazed joints. Use the fewest possible joints.

D. Makeup-water piping installed aboveground shall be the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

E. Makeup-Water Piping Installed Belowground: Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

F. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

G. Air-Vent Piping:
   1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
   2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

H. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to the following:
   1. Section 230523.12 "Ball Valves for HVAC Piping."
   2. Section 230523.14 "Check Valves for HVAC Piping."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install shutoff valve immediately upstream of each dielectric fitting.

T. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.3 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or flange kits.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.4 HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:
1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 7 feet.
2. NPS 1: Maximum span, 7 feet.
3. NPS 1-1/2: Maximum span, 9 feet.
4. NPS 2: Maximum span, 10 feet.
5. NPS 2-1/2: Maximum span, 11 feet.
6. NPS 3 and Larger: Maximum span, 12 feet.

D. 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 1-1/4Maximum span, 7 feet; minimum rod size, 3/8 inch.
   4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

G. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

H. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

3.6 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

3.7 CHEMICAL TREATMENT

A. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

B. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

C. Fill systems that have antifreeze or glycol solutions with the following concentrations:
   1. Minimum of 30 percent propylene glycol.

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
   4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
   5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.

3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:
1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes special-duty valves and specialties for the following:
   1. Hydronic specialty valves.
   2. Air-control devices.
   3. Strainers.
   4. Connectors.

B. Related Requirements:
   1. Section 230523.12 "Ball Valves for HVAC Piping" for specification and installation requirements for ball valves common to most piping systems.
   2. Section 230523.14 "Check Valves for HVAC Piping" for specification and installation requirements for check valves common to most piping systems.
   3. Section 230923.11 "Control Valves" for automatic control valve and sensor specifications, installation requirements, and locations.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Hydronic Specialty Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
   2. Air-control devices.
   3. Strainers

1.3 QUALITY ASSURANCE

A. ASME Compliance: Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 HYDRONIC SPECIALTY VALVES

A. Bronze, Calibrated-Orifice, Balancing Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
      a. Bell & Gossett; a Xylem brand.
      b. Nexus Valve, Inc.
   2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
   3. Ball: Brass or stainless steel.
   4. Plug: Resin.
   5. Seat: PTFE.

6. End Connections: Threaded or socket.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig.
10. Maximum Operating Temperature: 250 deg F.

B. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. AMTROL, Inc.
   b. Apollo Valves; Conbraco Industries, Inc.
   c. Bell & Gossett; a Xylem brand.
   d. Watts; a Watts Water Technologies company.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: Removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

C. Diaphragm-Operated Safety Valves: ASME labeled.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. AMTROL, Inc.
   b. Apollo Valves; Conbraco Industries, Inc.
   c. Bell & Gossett; a Xylem brand.
   d. Watts; a Watts Water Technologies company.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: Removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

D. Automatic Flow-Control Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Flowcon Americas LLC.
      b. HCI; Hydronics Components Inc.
      c. Nexus Valve, Inc.
   2. Body: Brass or ferrous metal.
   3. Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable.
   4. Combination Assemblies: Include bonze or brass-alloy ball valve.
   5. Identification Tag: Marked with zone identification, valve number, and flow rate.
   6. Size: Same as pipe in which installed.
   7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
   8. Minimum CWP Rating: 175 psig.
   9. Maximum Operating Temperature: 200 deg F.

2.2 AIR-CONTROL DEVICES

A. Manual Air Vents:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. AMTROL, Inc.
      b. Bell & Gossett; a Xylem brand.
      c. Nexus Valve, Inc.
   2. Body: Bronze.
   3. Internal Parts: Nonferrous.
   4. Operator: Screwdriver or thumbscrew.
   5. Inlet Connection: NPS 1/2.
   6. Discharge Connection: NPS 1/8.
   7. CWP Rating: 150 psig.
   8. Maximum Operating Temperature: 225 deg F.

2.3 STRAINERS

A. Y-Pattern Strainers:
   1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
   3. Strainer Screen: Stainless-steel, 40-mesh strainer, or perforated stainless-steel basket.
   4. CWP Rating: 125 psig.

2.4 CONNECTORS

A. Stainless-Steel Bellow, Flexible Connectors:
   1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
   2. End Connections: Threaded or flanged to match equipment connected.
   3. Performance: Capable of 3/4-inch misalignment.
   4. CWP Rating: 150 psig.
   5. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

C. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.

D. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
   1. Install tank fittings that are shipped loose.
   2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

E. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION 232116

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Rectangular ducts and fittings.
2. Round and flat oval ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.

B. Related Sections:
1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ANSI/ASHRAE 62.1.

1.3 ACTION SUBMITTALS

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

B. Shop Drawings:
1. Factory- and shop-fabricated ducts and fittings.
2. Penetrations through fire-rated and other partitions.
3. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
4. Hangers and supports, including methods for building attachment and vibration isolation.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
   2. Structural members to which duct will be attached.
   3. Penetrations of smoke barriers and fire-rated construction.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
   2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

PART 2 - PRODUCTS

2.1 RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE WALL ROUND AND FLAT OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
      a. Linx Industries (formerly Lindab).
      b. McGill AirFlow LLC.
      c. SEMCO LLC.
      d. Spiral Manufacturing Co., Inc.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
   2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.1 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND 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. Linx Industries (formerly Lindab).
   2. McGill AirFlow LLC.
   3. MKT Metal Manufacturing.
   4. SEMCO, LLC; part of FlaktGroup.
   5. Set Duct Manufacturing.
   6. Sheet Metal Connectors, Inc.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.
   1. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
      a. Construct ducts of galvanized sheet steel unless otherwise indicated.
      b. For ducts exposed to weather, construct outer duct of Type 304 stainless steel indicated by manufacturer to be suitable for outdoor installation.
   2. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
      a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
   3. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
      a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
      b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
   4. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Inner Duct: Minimum 24-gauge solid galvanized sheet steel.

D. Interstitial Insulation: Fibrous-glass liner complying with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
   2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
   3. Coat insulation with antimicrobial coating.
   4. Cover insulation with polyester film complying with UL 181, Class 1.

E. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C534/C534M, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
   1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature

2.2 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

D. 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 AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:
   1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
   2. Tape Width: 4 inches.
   3. Sealant: Modified styrene acrylic.
   4. Water resistant.
   5. Mold and mildew resistant.
   6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
   7. Service: Indoor and outdoor.
   8. Service Temperature: Minus 40 to plus 200 deg F.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
   10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Flanged Joint Sealant: Comply with ASTM C 920.
   1. General: Single-component, acid-curing, silicone, elastomeric.
   2. Type: S.
   3. Grade: NS.
   4. Class: 25.

5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.4 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

G. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts at a minimum to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
   1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   2. Outdoor, Supply-Air Ducts: Seal Class A.
   3. Outdoor, Exhaust Ducts: Seal Class C.
   4. Outdoor, Return-Air Ducts: Seal Class C.
   5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
   6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
   7. Unconditioned Space, Exhaust Ducts: Seal Class C.
   8. Unconditioned Space, Return-Air Ducts: Seal Class B.
   9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
   10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
   11. Conditioned Space, Exhaust Ducts: Seal Class B.
   12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.
   1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
   2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
   3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:
   1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
   2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:
   1. Air outlets and inlets (registers, grilles, and diffusers).
   2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
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 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

B. Perform duct pressure test per SMACNA guidelines.

3.8 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Supply Ducts:
1. Ducts Connected to Fan Coil Units, unit ventilators, and Terminal Units:
   a. Pressure Class: Positive 2-inch wg.
   b. SMACNA Leakage Class for Rectangular: 24.
   c. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Constant-Volume Air-Handling Units:
   a. Pressure Class: Positive 2-inch wg Insert value.
   b. SMACNA Leakage Class: 12.
3. Ducts Connected to Variable-Air-Volume Air-Handling Units:
   a. Pressure Class: Positive 4-inch wg.
   b. SMACNA Leakage Class: 3.
4. Ducts Connected to Equipment Not Listed Above:
   a. Pressure Class: Positive 2-inch wg.
   b. SMACNA Leakage Class: 12.

C. Return Ducts:
1. Ducts Connected to Air-Handling Units:
   a. Pressure Class: Positive or negative 2-inch wg.
   b. SMACNA Leakage Class: 12.
2. Ducts Connected to Equipment Not Listed Above:
   a. Pressure Class: Positive or negative 2-inch wg.
   b. SMACNA Leakage Class: 12.

D. Exhaust Ducts:
1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
   a. Pressure Class: Negative 2-inch wg.
   b. SMACNA Leakage Class: 12.
2. Ducts Connected to Air-Handling Units:
   a. Pressure Class: Positive or negative 2-inch wg.
   b. SMACNA Leakage Class: 12.
3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.
   a. Exposed to View: Type 304, stainless-steel sheet, No. 4 finish.
   b. Concealed: Type 304, stainless-steel sheet, No. 2D finish.
   c. Welded seams and joints.
   d. Pressure Class: Positive or negative 2-inch wg.
   e. Airtight/Watertight.
4. Ducts Connected to Equipment Not Listed Above:
   a. Pressure Class: Positive or negative 2-inch wg.
   b. SMACNA Leakage Class: 12.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
1. Ducts Connected to Air-Handling Units:
   a. Pressure Class: Positive or negative 2-inch wg.
   b. SMACNA Leakage Class: 12.
2. Ducts Connected to Equipment Not Listed Above:
   a. Pressure Class: Positive or negative 3-inch wg.
   b. SMACNA Leakage Class: 12.

F. Intermediate Reinforcement:
1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.

G. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:
   1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
   2) Mitered Type RE 4 without vanes.
b. Velocity 1000 to 1500 fpm:
   1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
   2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
   3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
c. Velocity 1500 fpm or Higher:
   1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
   3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
      3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
   b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
   c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

H. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   b. Rectangular Main to Round Branch: Spin in.
2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
   a. Velocity 1000 fpm or Lower: 90-degree tap.
   b. Velocity 1000 to 1500 fpm: Conical tap.
   c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Manual volume dampers.
2. Flange connectors.
3. Turning vanes.
4. Duct-mounted access doors.
5. Flexible connectors.
6. Flexible Ducts
7. Duct accessory hardware.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
1. Galvanized Coating Designation: G60.
2. Exposed-Surface Finish: Mill phosphatized.

B. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

C. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

E. 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 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. American Warming and Ventilating; a Mestek Architectural Group company.
      b. McGill AirFlow LLC.
      c. Nailor Industries Inc.
      d. Ruskin Company.
   2. Standard leakage rating.
   3. Suitable for horizontal or vertical applications.
   4. Frames:
      a. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel.
      b. Mitered and welded corners.
      c. Flanges for attaching to walls and flangeless frames for installing in ducts.
   5. Blades:
      a. Multiple or single blade.
      b. Parallel- or opposed-blade design.
      c. Stiffen damper blades for stability.
      d. Galvanized-steel, 0.064 inch thick.
   6. Blade Axles: Galvanized steel.
   7. Bearings:
      a. Oil-impregnated bronze or Molded synthetic.
      b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
   8. Tie Bars and Brackets: Galvanized steel.
   9. Accessories:
      a. Include locking device to hold single-blade dampers in a fixed position without vibration.

B. Jackshaft:
   1. Size: 0.5-inch diameter.
   2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
   3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:
   1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
   2. Include center hole to suit damper operating-rod size.
   3. Include elevated platform for insulated duct mounting.

2.4 FLANGE CONNECTORS

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. Ductmate Industries, Inc.
   2. Nexus PDQ.
   3. Ward Industries; a brand of Hart & Cooley, Inc.

B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.5 TURNING VANES

A. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

B. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger ducts.

2.6 DUCT-MOUNTED ACCESS DOORS

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. American Warming and Ventilating; a Mestek Architectural Group company.
   2. Ductmate Industries, Inc.
   3. Greenheck Fan Corporation.
   4. Nailor Industries Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
   1. Door:
      a. Double wall, rectangular.
      b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
      c. Vision panel.

d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
   a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
   c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
   d. Access Doors Larger than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.7 DUCT ACCESS PANEL ASSEMBLIES

A. Labeled according to UL 1978 by an NRTL.

B. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.

C. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.

D. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

E. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.8 FLEXIBLE CONNECTORS

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. Ductmate Industries, Inc.
   2. Hardcast, Inc.
   3. Ward Industries; a brand of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

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.

2.9 FLEXIBLE DUCTS

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. Flexmaster U.S.A., Inc.
   2. McGill AirFlow LLC.
   3. Thermaflex.

B. Noninsulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.
   1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
   2. Maximum Air Velocity: 4000 fpm.
   3. Temperature Range: Minus 10 to plus 160 deg F.

C. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
   1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
   2. Maximum Air Velocity: 4000 fpm.
   3. Temperature Range: Minus 20 to plus 210 deg F.
   4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

D. Flexible Duct Connectors:
   1. 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.
   2. Non-Clamp Connectors: Liquid adhesive plus tape.

2.10 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
   1. Install steel volume dampers in steel ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Upstream and downstream from duct filters.
   3. At outdoor-air intakes and mixed-air plenums.
   4. At drain pans and seals.
   5. Downstream from control dampers, backdraft dampers, and equipment.
   6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
   7. At each change in direction and at maximum 50-foot spacing.
   8. Upstream and downstream from turning vanes.
   9. Control devices requiring inspection.
   10. Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.

J. Access Door Sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches.
   2. Two-Hand Access: 12 by 6 inches.
   3. Head and Hand Access: 18 by 10 inches.
   4. Head and Shoulders Access: 21 by 14 inches.
   5. Body Access: 25 by 14 inches.
   6. Body plus Ladder Access: 25 by 17 inches.

K. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

L. Install flexible connectors to connect ducts to equipment.

M. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

N. Connect diffusers or light troffer boots to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

O. Connect flexible ducts to metal ducts with draw bands.

P. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.
   3. Operate fire, smoke, and combination dampers to verify full range of movement and verify that proper heat-response device is installed.
   4. Inspect turning vanes for proper and secure installation.

END OF SECTION 233300

SECTION 233713.13 - AIR DIFFUSERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Rectangular and square ceiling diffusers.

B. Related Requirements:
   1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers.
   2. Section 233713.23 " Registers and Grilles" for adjustable-bar register and grilles, fixed-face registers and grilles, and linear bar grilles.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   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. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 RECTANGULAR AND SQUARE CEILING DIFFUSERS

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. Titus.
   2. Krueger.
   3. A-J Manufacturing Co., Inc.
   4. Price

B. Devices shall be specifically designed for variable-air-volume flows.

C. Material: Aluminum.

D. Finish: Baked enamel, white.

E. Face Size: 24 by 24 inches, unless noted otherwise on drawings.

F. Face Style: Single cone.

G. Mounting: Surface or T-bar to match ceiling types on drawings.

H. Pattern: Fixed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install diffusers level and plumb.
B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers with airtight connections to ducts and to allow service and maintenance of air duct accessories.

3.2 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.13

SECTION 238223 - UNIT VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the installation and operational tests for Owner purchased vertical classroom-type unit ventilators and accessories.
   1. Part 2 information included below is for reference only as the equipment is owner furnished to the contractor for installation, including field-installed unit accessories.
   2. Installing contractor shall receive and inspect delivered units and assume responsibility of units once received.
   3. Coordinate with Temperature Controls Contractor for installation and start-up of DDC controllers.

1.2 INFORMATIONAL SUBMITTALS

A. Operation and Maintenance Data: to include in emergency, operation, and maintenance manuals. Obtain information from owner and include in record documents including warranty information.

PART 2 - PRODUCTS (FOR REFERENCE ONLY)

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Factory-packaged and -tested units rated according to AHRI 840, ASHRAE 33, and UL 1995.

C. Sound levels must meet or exceed minimum requirements within ANSI S12.60-2010 calculations.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. ChangeAir (a SystemAir company).
   2. Airedale (a Modine company).

2.3 MANUFACTURED UNITS

A. Description: Vertical up-flow unit ventilators consisting of finished cabinet, filters, hydronic heating and direct-expansion refrigerant cooling coils, drain pan, supply-air fan and motor in draw-through configuration, and relief-air fan and motor.
   1. Coil Configurations: Row split.
      a. Number of Heating Coils: One with two-pipe system.
      b. Number of Cooling Coils: One with direct-expansion refrigerant system.

2.4 CABINETS

A. Cabinet Frame and Panels: 16-gauge welded-steel frame *with non-standard 18-gauge* panels attached to frame with concealed fasteners. Removable panels shall be hinged with tamperproof fasteners.
   1. All internal components supported by frame supports.

B. Cabinet Finish: Powder coat baked enamel-textured finish, in manufacturer's standard color as selected by Architect.

C. Insulation: Minimum 1-inch thick, non-fibrous insulation minimum 0.7 lb/ft^3 density complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916. All exposed edges to be sealed.
   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.

D. Main and Auxiliary Drain Pans: Insulated stainless steel, formed as required by ASHRAE 62.1. Internal condensate drain piping configured for single through-the-wall discharge *below* the louver opening.

E. Return-Air Inlet: Punched return grille openings.

F. End Panels and Side Panels: Matching material and finish of cabinet.

2.5 COILS

A. Test and rate unit ventilator coils according to ASHRAE 33.

B. Hydronic Heating 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.

C. Direct-Expansion Refrigerant Cooling Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and brazed joints at fittings, installed with a thermal expansion valve sized to match the condensing unit. Comply with AHRI 210/240, and leak test to minimum 450 psig for a minimum 300-psig working pressure. Include thermal expansion valve matching remote condensing unit capacity.
   1. Provide primary direct expansion coil in evaporator coil section mounted with *insulated stainless steel drain pan and lines*.

2.6 SUPPLY AND RELIEF FANS

A. Fan and Motor Board: Removable.

B. Fans: Double inlet, centrifugal blower; directly connected to motor.
   1. *Supply fans shall be dual fan assemblies for improved sound performance which generates the least dBs from the unit.*
   2. Fan Shaft and Bearings: Hollow-steel shaft with permanently lubricated, resiliently mounted bearings.
   3. Motors: ECM, programmed to deliver the specified airflow. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
      a. ECM motors shall accept either a direct 0-10 VDC analog control signal for full modulation control of the fan or a 24 VAC digital signal required fan output.
   4. Wiring Termination: Connect motor to chassis wiring with plug connection.

2.7 DAMPERS

A. Return-Air Dampers: Insulated galvanized-steel blades with edge and end seals and nylon bearings; with electric actuator.

B. Outdoor-Air Dampers: Low-leakage parallel blade design. Frame and blades shall be constructed of extruded aluminum with streamline or airfoil design. Blades with edge and end seals, concealed linkage and bronze bearings; with electric actuator.

C. Relief-Air Dampers: Standard pressure sensitive static relief damper not requiring an actuator located on the leaving side of the relief fan.

D. Actuators: Belimo spring return damper actuator with minimum torque of 18 in/lb. Actuator must provide proportional damper control in response to input of 2 to 10 VDC.

E. Comply with ASHRAE/IES 90.1.

2.8 FILTERS

A. Each unit shall be equipped with a 2” MERV 13 pleated filter located to provide 100% filtration of both re-circulated and outside fresh air.

2.9 ACCESSORIES

A. General: The equipment schedule on the Drawings indicates which units receive the below accessories.

B. Exterior Louver: 4", weather-resistant, aluminum with standard powder coated paint finish from manufacturer's standard color list (Bronze). Louver shall be lined with ½" galvanized bird screen mesh. Louver size and design shall be matched to the model to provide proper ventilation air intake ensuring no water ingress and room air exhaust.

C. Wall Sleeve: Provide a trim-able, 12" deep, 22-gauge metal wall sleeve. Wall sleeve to be included with the standard louver with appropriate metal dividers to separate intake and exhaust air at standard sill height.

D. Top Duct Cover: A 3-sided, non-insulated cosmetic top duct cover shall be included with each unit ventilator. The cover shall be constructed of heavy 18-gauge steel with textured powder coat painted finish to match the unit ventilator. The top duct cover height shall be standard 20" that can be cut down to be 2" to 3" above the suspended ceiling height. Where the duct cover is paired with a unit with a rear plenum, the duct cover shall extend the depth of the rear plenum, so that there is not a gap between the mounting wall and the top duct cover.

E. Top Plenum with Discharge Grilles: A 5-sided, double insulated sound attenuating plenum. The 24" high top plenum shall be designed and constructed with sound attenuation baffles to ensure all 3 discharge grilles receive an equal amount of airflow. It shall be constructed of heavy 18-gauge steel with textured powder coat paint finished matching cabinet color.

F. Rear plenum: The plenum shall be constructed of heavy 18-gauge steel with a 1" flange for unit mounting and painted in textured powder coated finish to match cabinet color. The plenum is factory insulated with 1" acoustic material and includes a full uninsulated back. The rear plenum is supplied assembled with field mounting to the unit required. The rear plenum depth shall be standard 10" and height to match the unit height.

G. Pipe chase: A standard 6" pipe chase constructed from heavy 18-gauge steel with a textured powder coat paint finished to match cabinet color shall be included with each unit ventilator. Where the pipe chase is paired with a unit with a rear plenum, the pipe chase shall extend the depth of the rear plenum, so that there is not a gap between the mounting wall and the pipe chase.

2.10 FACTORY HYDRONIC/REFRIGERANT PIPING PACKAGE

A. Internal Piping: ASTM B 88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet. Provide crossover piping with shutoff valves.

B. Hydronic Control Valves: Electric actuators compatible with terminal controller and building controls.
   1. Two-way, modulating control valve for hot-water heating coil. Refer to schedules for units that may require three-way valves.

C. Isolation Valves, Strainers, Unions, and Balance Valves:
   1. Two-Piece Ball Valves: Bronze body with stainless-steel ball and stem and galvanized-steel lever handle for each supply and return connection. If balancing device is combination shutoff type with memory stop, isolation valve may be omitted on the return.
   2. 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.
   3. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A126, 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.
   4. Wrought-Copper Unions: ASME B16.22.

D. Connection Location: Coordinate connection locations with final installation location and verify left or right hand stub outs on top of unit with Architect during shop drawing submittal process.

2.11 SELF-CONTAINED REFRIGERATION COMPONENTS

A. Note: this section is not applicable to units with remote DX condensing units.

B. Description: Components shall be factory assembled and tested within unit ventilator requiring no field fabrication or installation of line sets and accessories; consisting of compressors, condenser coils, fans, motors, and refrigerant receivers; removable for maintenance, with plug and receptacle connections for control and power wiring. Construct, test, and rate condensing units according to AHRI 210/240 and ASHRAE 15.

C. Compressor: Two-stage hermetic scroll type with internal unloading mechanism to provide capacity control and to enable part load efficiencies to be increased; internally isolated on four (4) vibration isolators for quiet operation with factory-installed safety devices as follows:
   1. Antirecycle timer.
   2. High-pressure cutout.
   3. Low-pressure cutout or loss-of-charge switch.
   4. Internal thermal-overload protection.
   5. Current- and voltage-sensitive safety devices.

D. Compressor Acoustic Wrap with Base: For improved sound attenuation, include compressor sound deadening blanket wrap, factory installed. Cover shall be easily removable for service.

E. Refrigerant Circuit: System shall be designed and charged with R-410A refrigerant and oil, and contain a factory fitted thermal expansion device, filter drier, charging and service fittings, and sight glass for system observation.

F. Crankcase heater.

G. Condenser: Copper-tube, aluminum-fin coil, with drain pan.

2.12 BASIC UNIT CONTROLS

A. The unit ventilator manufacturer shall prepare the unit to be “DDC Ready”, meaning the electrical box with all required relays and transformers for the controller to operate. All controller wiring interface, programming, sequences of operation, commissioning of controls and documentation will be the responsibility of the controls contractor.
   1. The unit manufacturer shall provide all necessary unit documentation and wiring diagrams necessary for onsite installation of a DDC controller.
   2. Once the unit ventilator is installed onsite, a direct digital control (DDC) controller shall be supplied and installed by the Temperature Controls Contractor.

B. Basic Unit Controls:
   1. Control voltage transformer.
   2. Control relays.
   3. Motor control boards.
   4. Damper actuators.
   5. Valve actuators.
   6. Low-temperature limit sensor (freezestat) located on discharge side on heating coil to prevent hot water coil from freezing.
   7. Compressor controls for unit ventilators with self-contained refrigeration components.
   8. Factory condensate pan overflow switch.

C. Electrical Connection: Factory wired to provide power to motors and controls for a single electrical connection.
   1. Non-fused disconnect by manufacturer.
   2. Door switch for control voltage interrupt to disable the mechanical components when service panel is removed.
   3. All internal functions must be fuse protected by a time delay fuse properly rated for the amperage load.

2.13 CAPACITIES AND CHARACTERISTICS

A. Refer to schedule on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, to receive unit ventilators for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electrical connections to verify actual locations before unit ventilator installation.

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

3.2 INSTALLATION

A. Install unit ventilators per manufacturer’s instructions and to comply with NFPA 90A.

B. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other 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 unit ventilator factory hydronic piping package. Install piping package if shipped loose.
   3. Connect condensate drain.

B. Install refrigerant piping as required by Section 232300 "Refrigerant Piping," and add refrigerant as required to compensate for length of piping.

C. Connect supply-air and return-air ducts to unit ventilators with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. A factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections is provided by owner as part of the equipment-pre-purchase scope. Coordinate with service representative for equipment start up.

3.5 DEMONSTRATION

A. A manufacturer’s representative to Train Owner's maintenance personnel to adjust, operate, and maintain equipment is provided by owner as part of the equipment-pre-purchase scope. Coordinate representative for equipment training/demonstration.

END OF SECTION 238223

SECTION 260000 - GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Drawings and specifications.
2. Scope of work.
3. Codes, permits and inspections.
4. Interferences.
5. Materials and workmanship.
6. Acceptance.

1.2 DRAWINGS AND SPECIFICATIONS

A. The Architectural, Structural, Mechanical, Electrical, and equipment drawings and specifications are hereby incorporated into and become a part of this Division. Contractor shall examine all such drawings and specifications and become thoroughly familiar with provisions contained herein and the submission of his bid shall be construed as indicating such knowledge. All drawings and specifications will be available according to Section 00200 - Instructions to Bidders.

B. Electrical drawings are in part diagrammatic, intending to convey scope of work, indicating general arrangement of panelboards, switches, equipment, conduit, outlets, and other devices. Due to the diagrammatic nature of the drawings, many of the necessary individual component parts are not indicated but shall be included by the Contractor for a complete and operable electrical system. Follow drawings in laying out work, and verify places for installation of materials and equipment. Whenever a question exists as to exact intended location of outlets or equipment, obtain instructions from the Engineer before proceeding with work. Information presented on these drawings is as accurate as preliminary surveys and planning can determine, but complete accuracy is not guaranteed, and Contractor field verification of all dimensions and conditions is required.

C. All changes from these drawings necessary to make the work conform to the building as constructed and to fit the work of other trades or to conform to the rules and regulations of the State, City, or Municipal bodies having jurisdiction, are to be made by electrical contractor, at his own expense.

D. The exact locations of apparatuses, fixtures, equipment and conduits shall be ascertained from the Owner or his representative in the field, and the work shall be laid out accordingly. Should the Contractor fail to ascertain such locations, the work shall be changed at his own expense when so ordered by the Owner. The Owner reserves the right to make minor changes in the location of conduit and equipment up to the time of installation, without additional cost.
   1. Unless otherwise indicated, within industrial buildings, all conduit, cable tray and busway shall be routed at the elevation of the roof framing except where individual drops are made to distribution equipment, utilization equipment, fixtures or devices.

E. The electrical drawings and specifications are intended to supplement each other and any material or labor called for in one shall be supplied even though not specifically mentioned in both. Labor and/or materials neither shown nor specified, but necessary for the completion and proper functioning of the system, shall be provided by Contractor.

F. Should conflicting information exist in the drawings and/or specifications, the better quality or greater quantity shall be provided when a clarification cannot be obtained.

1.3 SCOPE OF WORK

A. Supply all labor and material to complete all electrical work shown on the drawings, specified herein or required to complete the construction of the building as shown.

B. The listing of article or material, operation or method, requires that the Contractor shall provide and install, unless noted to be supplied by others, each item listed of quality or subject to qualification noted. Each operation shall be performed according to standard practice, manufacturer's instructions and conditions stated, providing all necessary labor, equipment and incidentals.

C. The principal items of work include but are not limited to the following:
   1. Electrical demolition work as indicated or required.
   2. Complete electrical service modifications at facility.
   3. Complete feeder and branch circuit wiring system.
   4. Complete raceway system.
   5. Temporary electric service for construction.
   6. Testing of all electrical equipment and each system.
   7. Wiring of mechanical equipment.

D. Responsibility: the electrical contractor shall be responsible for the work of all his sub-contractors and the materials of all his suppliers. Include all materials, labor, and equipment required for a complete and working installation. Do not supply materials that will not work in the particular situation of this project.

1.4 CODES, PERMITS AND INSPECTIONS

A. Install all work in full accord with codes, rules and regulations of Municipal, City, County, State and Public Utilities and all other authorities having jurisdiction over the premises. This shall include all requirements of the City Building Code, regulations of the State Department of Industrial Relations, MIOSHA and the requirements of the National Electrical Code, as interpreted by the Local Inspection Division. All these codes, rules, and regulations are hereby incorporated into this specification.

B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

C. Wiring methods used shall be suitable for the installation and use in conformity with the provisions of the National Electric Code. Listed or labeled equipment shall be used or installed in accordance with any instructions included in the listing or labeling.

D. Comply with specification requirements which are in excess of code requirements and not in conflict with same.

E. The Contractor shall secure all permits and certificates of inspection incidental to his work, required by the foregoing authorities. All such certificates shall be delivered to the Owner in duplicate, before final payment on contract will be allowed. The Contractor shall pay all fees, charges and other expenses in connection therewith.

1.5 INTERFERENCES

A. Before installing any of this work, the Contractor shall see that it does not interfere with clearances for the erection of finish beams, columns, pilasters, walls, ducts, and other structural, mechanical, or architectural members as shown on the drawings. If any work is so installed and later the architectural design cannot be followed, electrical contractor shall, at his own expense, make such changes in his work as the Architect or Engineer may direct to permit the completion of the other work in accordance with the drawings and specifications.

B. It shall be the duty of the Contractor to report any interferences between his work and that of any other Contractor to the Engineer as soon as they are discovered. The Engineer will determine which equipment shall be relocated regardless of which was first installed.

1.6 MATERIALS AND WORKMANSHIP

A. All work shall be installed in a practical and workmanlike manner by competent workers, skilled in their branch of the trade.

B. Unless expressly specified or indicated on the drawings to the contrary, all materials shall be new and free from defects and shall be the best of their several kinds.

C. Where materials, equipment and fixtures are recessed in fire rated walls, ceilings, soffits or floors, provide the necessary fire rated covers or box construction to maintain the fire rating.

D. During installation and construction, enclosures, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of foreign matter; and be vacuum cleaned both inside and outside before testing and operating and repainting if required.

E. During the construction operation and at its completion, the Contractor shall remove all debris and excess materials caused by his work and he shall leave the area of the operation broom clean.

1.7 ACCEPTANCE

A. As a precedent to requesting a final inspection, submit written statements regarding the following:
   1. All work required by contract is completed.
   2. All tests required by these specifications have been performed. Include a dated copy of all test results signed by the persons performing the test and the witnesses of the test.
   3. The Owner's Representative has been instructed in the operation and maintenance of the electrical systems. This shall include training by Manufacturer's Representatives as well as by the installers. Indicate the date of the instructions and the names of the Owner's representative.
   4. Certificates of inspections from authorities having jurisdiction.
   5. Spare items and parts as called for in specifications, to the Owner, obtain a written receipt and supply a copy of these receipts to the Engineer.
   6. Written warranty and first years' service. Provide extended warranty where applicable.
   7. A listing of the various Electrical Trades, their equipment suppliers, etc., including each firm's contact name, telephone number, emergency telephone number, etc. to the Owner for use during building warranty period.
   8. Copies of "Receipts from the Owner" for all "Spare" items turned over to him.
   9. A complete set of record "as built" drawings on mylar. "As built" drawings shall include all addenda and change orders as well as any and all changes required in the field.
   10. Required operating and maintenance instructions and wiring diagrams on all equipment and systems to the Owner's operating personnel.

1.8 RELATED SECTIONS

A. Section 00437 - Supplement G, List of Supplementary Electrical Information. Submit along with your bid a bid supplement listing the actual equipment manufacturers that your proposal is based on. Failure to submit supplement will result in disqualification of bid.

B. Section 01780 - Closeout Submittals.

C. Division 23 - Heating, Ventilating, and Air-Conditioning (HVAC)

1.9 SUBSTITUTIONS

A. Refer to Section 012500 – Substitution Procedures.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION – NOT USED

END OF SECTION 260000

SECTION 260001 - ELECTRICAL SERVICE ENTRANCE

GENERAL

1.1 REFERENCE STANDARDS

A. NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting; National Electrical Contractors Association; 2015.

B. NFPA 70 – National Electrical Code; National Fire Protection Association; 2017

1.2 SYSTEMS DESCRIPTION

A. System Characteristics: 120/208, three phase, four-wire, 60 Hertz.

B. Service Entrance: Underground.

1.3 QUALITY ASSURANCE

A. Perform work in accordance with utility company written requirements and NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PRODUCTS - NOT USED

EXECUTION

1.4 PREPARATION

A. Arrange with utility provider to obtain permanent electric service to the Project.

B. Verify that field measurements are as indicated on utility company drawings.

1.5 INSTALLATION

A. Install transformer pad, metering transformer cabinets, and meter base as required by utility company.

B. Install securely, in a neat and workmanlike manner, as specified in NECA 1.

END OF SECTION 260001

SECTION 260002 – EQUIPMENT WIRING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Electrical connections to equipment

1.2 REFERENCE STANDARDS

A. NEMA WD 1 – General Color Requirements for Wiring Devices; National Electrical Manufacturers Association.

B. NEMA WD 6 – Wiring Devices – Dimensional Requirements; National Electrical Manufacturers Association.

C. NFPA 70 – National Electrical Code; National Fire Protection Association.

1.3 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.4 COORDINATION

A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.

B. Determine connection location and requirements.

C. Sequence rough-in of electrical connections to coordinate with installation of equipment.

D. Sequence electrical connections to coordinate with start-up of equipment.

E. Provide power to all electrically operated equipment whether or not circuit numbers are shown. Review entire set of documents for equipment to be provided.

F. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Vertical Unit Ventilators as specified in Mechanical drawings and equipment shop drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring and energizing.

3.2 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

E. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

F. Install terminal block jumpers to complete equipment wiring requirements.

G. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION 260002

SECTION 260501 - MINOR ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Electrical demolition.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 - EXECUTION

3.1 PERFORMANCE REQUIREMENTS

A. Refer to Section 024119 “Selective Demolition.”

3.2 EXAMINATION

A. Verify field measurements and circuiting arrangements are as shown on Drawings.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition drawings are based on casual field observation and existing record documents.

D. Report discrepancies to Architect/Engineer before disturbing existing installation.

E. Beginning of demolition means installer accepts existing conditions.

3.3 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings to be removed.

B. Coordinate utility service outages with utility company.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

D. Existing Electrical Service: Maintain existing system in service for temporary power. Disable system only to make switchovers and connections. Minimize outage duration.

1. Coordinate outages with construction manager and all other trades.
2. Demolish existing service once new service is operational.

E. Existing Fire Alarm System: Modify existing system as noted on drawings.

F. Where concrete slabs are shown to be sawcut and removed, verify locations of conduits in or under the slab using x-ray or other method.

3.4 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Remove, all existing electrical installations, except where shown to be reused. Coordinate to accommodate new construction.

B. Remove abandoned wiring to source of supply.

C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors that remain, and patch surfaces.

D. Repair adjacent construction and finishes damaged during demolition and extension work.

E. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

F. Extend existing installations using materials and methods as specified.

END OF SECTION 260501

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Copper building wire.
   2. Metal-clad cable, Type MC.
   3. Fire-alarm wire and cable.
   4. Connectors and splices.

1.2 ACTION SUBMITTALS

A. Product Data:
   1. Copper building wire.
   2. Metal-clad cable, Type MC.
   3. Fire-alarm wire and cable.
   4. Connectors and splices.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 or ASTM B496 for stranded conductors.

D. Conductor Insulation:
   1. Type NM. Comply with UL 83 and UL 719.
   2. Type THHN and Type THWN-2. Comply with UL 83.
   3. Type XHHW-2. Comply with UL 44.

2.2 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. Comply with UL 1569.
   3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Circuits:
   1. Single circuit.
   2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Ground Conductor: Insulated.

F. Conductor Insulation:
   1. Type TFN/THHN/THWN-2. Comply with UL 83.

G. Armor: Steel or aluminum, interlocked.

2.3 FIRE-ALARM WIRE AND CABLE

A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG unless other size is recommended by system manufacturer.
   1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
   1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.

2.4 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
   1. Material: Copper or aluminum.
   2. Type: One or two hole with standard barrels.
   3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders:
   1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits:
   1. Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.

B. Feeders: Type THHN/THWN-2, single conductors in raceway.

C. Branch Circuits: Type THHN/THWN-2, single conductors in raceway. Metal-clad cable, Type MC, may be used where concealed in ceilings, walls and partitions.

3.3 INSTALLATION, GENERAL

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points in accordance with Section 260533.13 "Conduits for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 INSTALLATION OF FIRE-ALARM WIRE AND CABLE

A. Comply with NFPA 72.

B. Wiring Method: Install wiring in metal pathway according to Section 260529 "Hangers and Supports for Electrical Systems."
   1. Install plenum cable in environmental airspaces, including plenum ceilings.
   2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system must be installed in a dedicated pathway system.
      a. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
   3. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is permitted.
   4. Signaling Line Circuits: Power-limited fire-alarm cables may be installed in the same cable or pathway as signaling line circuits.

C. Wiring within Enclosures: 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 fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another 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.

F. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Comply with requirements in Section 284621.11 "Addressable Fire-Alarm Systems" for connecting, terminating, and identifying wires and cables.

3.6 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.8 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.9 FIELD QUALITY CONTROL

A. Perform Tests and Inspections:
   1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
   2. Perform each of the following visual and electrical tests:
      a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
      b. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.

B. Cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports to record the following:
   1. Procedures used.
   2. Results that comply with requirements.
   3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Grounding and bonding conductors.
2. Grounding and bonding clamps.
3. Grounding and bonding bushings.
4. Grounding and bonding hubs.
5. Grounding and bonding connectors.
6. Grounding and bonding busbars.
7. Grounding (earthing) electrodes.

1.2 ACTION SUBMITTALS

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

B. Field Quality-Control Submittals:
1. Field quality-control reports.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

A. Equipment Grounding Conductor:
1. General Characteristics: 600 V, THHN/THWN-2 or THWN-2, copper wire or cable, green color, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. ASTM - Bare Copper Grounding and Bonding Conductor:
1. Referenced Standards: Complying with one or more of the following:
a. Soft or Annealed Copper Wire: ASTM B3

2.2 GROUNDING AND BONDING CLAMPS

A. Description: Clamps suitable for attachment of grounding and bonding conductors to grounding electrodes, pipes, tubing, and rebar.

B. Source Limitations: Obtain products from single manufacturer.

C. Performance Criteria:
   1. Regulatory Requirements:
      a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   2. Listing Criteria:
      a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
      b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

D. UL KDER and KDSH - Hex-Fitting-Type Pipe and Rod Grounding and Bonding Clamp:
   1. General Characteristics:
      a. Two pieces with stainless steel bolts.
      b. Clamp Material: Silicon bronze, aluminum or brass.
      c. Listed for outdoor use.

E. UL KDER and KDSH - U-Bolt-Type Pipe and Rod Grounding and Bonding Clamp:
   1. General Characteristics:
      a. Clamp Material: Aluminum or brass.
      b. Listed for outdoor use.

F. UL KDER - Beam Grounding and Bonding Clamp:
   1. General Characteristics: Mechanical-type, terminal, ground wire access from four directions; with dual, tin-plated or silicon bronze bolts.

G. UL KDER - Exothermically Welded Connection:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. ABB, Electrification Business.
      b. ERICO; brand of nVent Electrical plc.
   2. General Characteristics: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING AND BONDING BUSHINGS

A. Description: Bonding bushings connect conduit fittings, tubing fittings, threaded metal conduit, and unthreaded metal conduit to metal boxes and equipment enclosures, and have one or more bonding screws intended to provide electrical continuity between bushing and enclosure. Grounding bushings have provision for connection of bonding or grounding conductor and may or may not also have bonding screws.

B. Performance Criteria:
   1. Regulatory Requirements:
      a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   2. Listing Criteria:
      a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

C. UL KDER - Bonding Bushing:
   1. General Characteristics: Threaded bushing with insulated throat.

D. UL KDER - Grounding Bushing:
   1. General Characteristics: Threaded bushing with insulated throat and mechanical-type wire terminal.

2.4 GROUNDING AND BONDING HUBS

A. Description: Hubs with certified grounding or bonding locknut.

B. Performance Criteria:
   1. Regulatory Requirements:
      a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   2. Listing Criteria:
      a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

C. UL KDER - Grounding and Bonding Hub:
   1. General Characteristics: Insulated, gasketed, watertight hub with mechanical-type wire terminal.

2.5 GROUNDING AND BONDING CONNECTORS

A. Source Limitations: Obtain products from single manufacturer.

B. Performance Criteria:
   1. Regulatory Requirements:
      a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   2. Listing Criteria:
      a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
      b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

C. UL KDER - Pressure-Type Grounding and Bonding Busbar Cable Connector:
   1. General Characteristics: Copper or copper alloy, for compression bonding of one or more conductor directly to copper busbar. Listed for direct burial.

D. UL KDER - Lay-In Lug Mechanical-Type Grounding and Bonding Busbar Terminal:
   1. General Characteristics: Mechanical-type, aluminum or copper terminal with set screw.

E. UL KDER - Split-Bolt Pressure-Type Grounding and Bonding Cable Connector:
   1. General Characteristics: Bolts that surround cable and bond to cable under compression when nut is tightened.
      a. Copper or copper alloy.

2.6 GROUNDING AND BONDING BUSBARS

A. Description: Miscellaneous grounding and bonding device that serves as common connection for multiple grounding and bonding conductors.

B. Source Limitations: Obtain products from single manufacturer.

C. Performance Criteria:
   1. Regulatory Requirements:
      a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   2. Listing Criteria:
      a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

D. UL KDER - Equipment Room Grounding and Bonding Busbar:
   1. General Characteristics:
      a. Bus: Rectangular bar of annealed copper.
      b. Mounting Stand-Off Insulators: Lexan or PVC.
         1) Comply with UL 891 for use in 600 V switchboards, impulse tested at 5000 V.
   2. Options:
      a. Dimensions: 1/4 by 4 inch in cross section; length as required to complete all required connections.
      b. Predrilled Hole Pattern: Suitable for installing specified grounding and bonding connectors.
      c. Mounting Hardware: Stand-off brackets that provide 2-inch clearance to access rear of bus. Brackets and bolts must be stainless steel.

2.7 GROUNDING (EARTHING) ELECTRODES

A. Description: Grounding electrodes include rod electrodes, ring electrodes, metal underground water pipes, metal building frames, concrete-encased electrodes, and pipe and plate electrodes.

B. Performance Criteria:
   1. Regulatory Requirements:
      a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   2. Listing Criteria:
      a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

C. UL KDER - Rod Electrode:
   1. General Characteristics: Copper-clad steel; 3/4 inch by 10 ft.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.

B. Inspect test results of grounding system measured at point of electrical service equipment connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of electrical service equipment only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF BUSBARS

A. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Install bus horizontally, on insulated spacers 2 inch minimum from wall, 6 inch above finished floor unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.3 SELECTION OF GROUNDING AND BONDING CONDUCTORS

A. Conductors: Install solid conductor for 8 AWG and smaller, and stranded conductors for 6 AWG and larger unless otherwise indicated.

B. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.

C. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8-inch-wide and 1/16 inch thick.

D. Underground Grounding Conductors: Install bare copper conductor, 2/0 AWG minimum unless otherwise indicated.
   1. Bury at least 30 inch below grade.
   2. Duct-Bank Grounding Conductor: Bury 12 inch above duct bank when indicated as part of duct-bank installation.

3.4 SELECTION OF CONNECTORS

A. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors unless otherwise indicated.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.
   4. Connections to Structural Steel: Welded connectors.

3.5 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:
   1. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
   2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:
   1. Conductors:
      a. Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
   2. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
      a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
      b. Make connections with clean, bare metal at points of contact.
      c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
      d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
      e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
      f. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
         1) Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate adjacent parts.
         2) Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
         3) Use exothermic-welded connectors for outdoor locations; if disconnect-type connection is required, use bolted clamp.
      g. Grounding and Bonding for Piping:
         1) Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use bolted clamp connector or bolt lug-type connector to pipe flange by using one of lug bolts of flange. Where dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2) Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with bolted connector.
3) Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

h. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

i. Grounding for Steel Building Structure: Install driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 ft. apart.

3. Electrodes:
   a. Ground Rods: Drive rods until tops are 2 inch below finished floor or final grade unless otherwise indicated.
      1) Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
      2) Use exothermic welds for below-grade connections.
   b. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least same distance from other grounding electrodes, and connect to service grounding electrode conductor.
   c. Ring Electrode: Install grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around perimeter of area or item indicated.
      1) Install tinned-copper conductor not less than 4/0 AWG for ring electrode and for taps to building steel.
      2) Bury ring electrode not less than 24 inch from building's foundation.
4. Grounding at Service:
   a. Equipment grounding conductors and grounding electrode conductors must be connected to ground bus. Install main bonding jumper between neutral and ground buses.
5. Grounding Underground Distribution System Components:
   a. Duct-Bank Grounding Conductor: Bury 12 inch above duct bank when indicated as part of duct-bank installation.
   b. Comply with IEEE C2 grounding requirements.
   c. Pad-Mounted Transformers and Switches: Install two ground rods and ring electrode around pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than 2 AWG for ring electrode and for taps to equipment grounding terminals. Bury ring electrode not less than 6 inch from foundation.

6. Equipment Grounding:
    a. Install insulated equipment grounding conductors with feeders and branch circuits.
    b. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
    c. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:
    1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
    2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.
    3. Test completed grounding system at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal.
        a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
        b. Perform tests by fall-of-potential method in accordance with IEEE Std 81.
        c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

B. Nonconforming Work:
    1. Grounding system will be considered defective if it does not pass tests and inspections.
    2. Remove and replace defective components and retest.

C. Collect, assemble, and submit test and inspection reports.
    1. Report measured ground resistances that exceed 5 ohms.

3.7 PROTECTION

A. After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Support, anchorage, and attachment components.
   2. Fabricated metal equipment support assemblies.

1.2 ACTION SUBMITTALS

A. Product Data:
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
      a. Slotted support systems, hardware, and accessories.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inch on center in at least one surface.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Cooper B-line; brand of Eaton, Electrical Sector.
      b. G-Strut.
      c. Unistrut; Atkore International.
   2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
   3. Material for Channel, Fittings, and Accessories: Galvanized steel.
   4. Channel Width: 1-5/8 inches.
   5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

B. 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.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
   4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
   5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
   6. Toggle Bolts: All steel springhead type.
   7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 SELECTION

A. Comply with the following standards for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:
   1. NECA NEIS 101
   2. NECA NEIS 105.

B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways specified in Section 260533.13 "Conduits for Electrical Systems."

D. Comply with requirements for boxes specified in Section 260533.16 "Boxes and Covers for Electrical Systems."

E. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as required by NFPA 70. Minimum rod size must be 1/4 inch in diameter.

F. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps.

3.2 INSTALLATION OF SUPPORTS

A. Comply with NECA NEIS 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA NEIS 1, EMT IMC and ERMC may be supported by openings through structure members, in accordance with NFPA 70.

C. 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 must be weight of supported components plus 200 lb.

D. 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 inch thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inch thick.
   6. To Steel: Beam clamps (MSS SP-58, 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.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M. Submit welding certificates.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inch 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 Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base as follows:
   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:
   1. Comply with requirements in Section 099123 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 260529

SECTION 260533.13 - CONDUITS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Type EMT-S duct raceways and elbows.
2. Type ERMC-S duct raceways, elbows, couplings, and nipples.
3. Type FMC-S and Type FMC-A duct raceways.
4. Type LFMC duct raceways.
5. Type PVC duct raceways and fittings.
6. Fittings for conduit, tubing, and cable.
7. Electrically conductive corrosion-resistant compounds for threaded conduit.
8. Solvent cements.

B. Products Installed, but Not Furnished, under This Section:
1. See Section 260553 "Identification for Electrical Systems" for electrical equipment labels.

C. Related Requirements:
1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" for nonmetallic underground conduit with conductors (Type NUCC).
3. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes, and underground utility construction.

1.2 DEFINITIONS

A. Conduit: A structure containing one or more duct raceways.

B. Duct Raceway: A single enclosed raceway for conductors or cable.

C. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.

1.3 ACTION SUBMITTALS

A. Product Data:
1. Type EMT-S duct raceways and elbows.
2. Type ERMC-S duct raceways, elbows, couplings, and nipples.
3. Type FMC-S and Type FMC-A duct raceways.
4. Type LFMC duct raceways.
5. Type PVC duct raceways and fittings.
6. Fittings for conduit, tubing, and cable.

7. Electrically conductive corrosion-resistant compounds for threaded conduit.
8. Solvent cements.

PART 2 - PRODUCTS

2.1 TYPE EMT-S DUCT RACEWAYS AND ELBOWS

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   2. Listing Criteria: UL CCN FJMX; including UL 797.

B. Source Quality Control:
   1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

C. UL FJMX - Steel Electrical Metal Tubing (EMT-S) and Elbows:
   1. Material: Steel.
   2. Options:
      a. Exterior Coating: Zinc.
      b. Interior Coating: Zinc with organic top coating.
      c. Minimum Trade Size: Metric designator 21 (trade size 3/4).
      d. Colors: As indicated on Drawings.

2.2 TYPE ERMC-S DUCT RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   2. Listing Criteria: UL CCN DYIX; including UL 6.

B. Source Quality Control:
   1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

C. UL DYIX - Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:
   1. Exterior Coating: Zinc.
   2. Options:
      a. Interior Coating: Zinc with organic top coating.
      b. Minimum Trade Size: Metric designator 21 (trade size 3/4).
      c. Colors: As indicated on Drawings.

2.3 TYPE FMC-S AND TYPE FMC-A DUCT RACEWAYS

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   2. Listing Criteria: UL CCN DXUZ; including UL 1.

B. Source Quality Control:
   1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

C. UL DXUZ - Steel Flexible Metal Conduit (FMC-S):
   1. Material: Steel.
   2. Options:
      a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

D. UL DXUZ - Aluminum Flexible Metal Conduit (FMC-A):
   1. Options:
      a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

2.4 TYPE LFMC DUCT RACEWAYS

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   2. Listing Criteria: UL CCN DXHR; including UL 360.

B. Source Quality Control:
   1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

C. UL DXHR - Steel Liquidtight Flexible Metal Conduit (LFMC-S):
   1. Material: Steel.
   2. Options:
      a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

2.5 TYPE PVC DUCT RACEWAYS AND FITTINGS

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   2. Listing Criteria: UL CCN DZYR; including UL 651.

B. Source Quality Control:
   1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

C. UL DZYR - Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:
   1. Dimensional Specifications: Schedule 40.
   2. Options:
      a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
      b. Markings: For use with maximum 90 deg C wire and for directional boring applications.

D. UL DZYR - Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:
   1. Dimensional Specifications: Schedule 80.
   2. Options:
      a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
      b. Markings: For use with maximum 90 deg C wire and for directional boring applications.

2.6 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Source Quality Control:
   1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

C. UL DWTT - Fittings for Type ERMC Duct Raceways:
   1. Listing Criteria: UL CCN DWTT; including UL 514B.
   2. Options:
      a. Material: Steel.
      b. Coupling Method: Threaded.
      c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

D. UL FKAV - Fittings for Type EMT Duct Raceways:
   1. Listing Criteria: UL CCN FKAV; including UL 514B.
   2. Options:
      a. Material: Steel.
      b. Coupling Method: Compression coupling.
      c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

E. UL ILNR - Fittings for Type FMC Duct Raceways:
   1. Listing Criteria: UL CCN ILNR; including UL 514B.

F. UL DXAS - Fittings for Type LFMC Duct Raceways:
   1. Listing Criteria: UL CCN DXAS; including UL 514B.

2.7 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   2. Listing Criteria: UL CCN FOIZ; including UL Subject 2419.

B. Source Quality Control:
   1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

C. UL FOIZ - Electrically Conductive Corrosion-Resistant Compound for Threaded Conduit:

2.8 SOLVENT CEMENTS

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
   2. Listing Criteria: UL CCN DWTT; including UL 514B.

B. Source Quality Control:
   1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

C. UL DWTT - Solvent Cements for Type PVC Duct Raceways and Fittings.

PART 3 - EXECUTION

3.1 SELECTION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of duct raceways. Consult Architect for resolution of conflicting requirements.

B. Outdoors:
   1. Exposed and Subject to Severe Physical Damage: ERMC.
   2. Exposed and Subject to Physical Damage: ERMC.
      a. Locations less than 2.5 m (8 ft) above finished floor.
   3. Exposed and Not Subject to Physical Damage: EMT.
   4. Concealed Aboveground: ERMC.
   5. Direct Buried: PVC-80.
   6. Concrete Encased Not in Trench: PVC-40.
   7. Concrete Encased in Trench: PVC-40.
   8. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

C. Indoors:
   1. Hazardous Classified Locations: ERMC.
   2. Exposed and Subject to Severe Physical Damage: ERMC. Locations include the following:
      a. Loading docks.
      b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
      c. Mechanical rooms.
      d. Gymnasiums.
   3. Exposed and Subject to Physical Damage: ERMC. Locations include the following:
      a. Locations less than 2.5 m (8 ft) above finished floor.
      b. Stub-ups to above suspended ceilings.
   4. Exposed and Not Subject to Physical Damage: EMT.
   5. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   6. Damp or Wet Locations: ERMC.
   7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

D. Duct Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.
   1. ERMC: Provide threaded-type fittings unless otherwise indicated.

3.2 INSTALLATION OF CONDUITS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:
   1. Type EMT-S: Article 358 of NFPA 70 and NECA NEIS 101.
   2. Type ERMC-S: Article 344 of NFPA 70 and NECA NEIS 101.
   3. Type FMC-S: Article 348 of NFPA 70 and NECA NEIS 101.
   4. Type LFMC: Article 350 of NFPA 70 and NECA NEIS 101.
   5. Type PVC: Article 356 of NFPA 70 and NECA NEIS 111.
   6. Expansion Fittings: NEMA FB 2.40.
   7. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:
   1. General Requirements for Installation of Duct Raceways:
      a. Complete duct raceway installation before starting conductor installation.
      b. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 ft above finished floor.
      c. Install no more than equivalent of three 90-degree bends in conduit run. Support within 12 inch of changes in direction.
      d. Make bends in duct raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70

minimum radii requirements. Provide only equipment specifically designed for material and size involved.

e. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
f. Support conduit within 12 inch of enclosures to which attached.
g. Install devices to seal duct raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of duct raceways at the following points:
    1) Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
    2) Where an underground service duct raceway enters a building or structure.
    3) Conduit extending from interior to exterior of building.
    4) Conduit extending into pressurized duct raceway and equipment.
    5) Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
    6) Where otherwise required by NFPA 70.
h. Do not install conduits within 2 inch of the bottom side of a metal deck roof.
i. Keep duct raceways at least 6 inch away from parallel runs of flues and steam or hot-water pipes. Install horizontal duct raceway runs above water and steam piping.
j. Cut conduit perpendicular to the length. For conduits metric designator 53 (trade size 2) and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
k. Install pull wires in empty duct raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inch of slack at both ends of pull wire. Cap underground duct raceways designated as spare above grade alongside duct raceways in use.
l. Install duct raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.
    1) Termination fittings with shoulders do not require two locknuts.
m. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to metric designator 35 (trade size 1-1/4) and insulated throat metal bushings on metric designator 41 (trade size 1-1/2) and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

2. Types ERMC:
    a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of duct raceway and fittings before making up joints. Follow compound manufacturer's published instructions.
3. Types FMC and LFMC:
    a. Provide a maximum of 72 inch of flexible conduit for recessed and semirecessed luminaires and equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

4. Types PVC:
   a. Do not install Type PVC conduit where ambient temperature exceeds 122 deg F. Conductor ratings must be limited to 75 deg C except where installed in a trench outside buildings with concrete encasement, where 90 deg C conductors are permitted.
   b. Comply with manufacturer's published instructions for solvent welding and fittings.

5. Duct Raceways Embedded in Slabs:
   a. Run duct raceways larger than metric designator 27 (trade size 1) below concrete slab.
   b. Arrange duct raceways to cross building expansion joints with expansion fittings at right angles to the joint.
   c. Arrange duct raceways to ensure that each is surrounded by minimum of 1 inch of concrete without voids.
   d. Do not embed threadless fittings in concrete unless locations have been specifically approved by Architect.
6. Stub-ups to Above Recessed Ceilings:
   a. Provide EMT for duct raceways.
   b. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
7. Duct Raceway Terminations at Locations Subject to Moisture or Vibration:
   a. Provide insulating bushings to protect conductors, including conductors smaller than 4 AWG. Install insulated throat metal grounding bushings on service conduits.
8. Duct Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.
   a. EMT: Provide setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
   b. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.
9. Expansion-Joint Fittings:
   a. Install in runs of aboveground PVC that are located where environmental temperature change may exceed 30 deg F and that have straight-run length that exceeds 25 ft.
   b. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
   c. Install expansion fittings at locations where conduits cross building or structure expansion joints.
   d. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's published instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
10. Duct Raceways Penetrating Rooms or Walls with Acoustical Requirements: Seal duct raceway openings on both sides of rooms or walls with acoustically rated putty or firestopping.

11. Identification: Provide labels for conduit assemblies, duct raceways, and associated electrical equipment.
    a. Provide warning signs.

D. Interfaces with Other Work:
1. Coordinate with Section 078413 "Penetration Firestopping" for installation of firestopping at penetrations of fire-rated floor and wall assemblies.
2. Coordinate with Section 260529 "Hangers and Supports for Electrical Systems" for installation of conduit hangers and supports.

3.3 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION 260533.13

SECTION 260533.16 - BOXES AND COVERS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Metallic outlet boxes, device boxes, rings, and covers.
2. Nonmetallic outlet boxes, device boxes, rings, and covers.
3. Junction boxes and pull boxes.
4. Cover plates for device boxes.
5. Hoods for outlet boxes.

B. Products Installed, but Not Furnished, under This Section:
1. See Section 260553 "Identification for Electrical Systems" for electrical equipment labels.

C. Related Requirements:
1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:
1. Metallic outlet boxes, device boxes, rings, and covers.
2. Nonmetallic outlet boxes, device boxes, rings, and covers.
3. Junction boxes and pull boxes.
4. Cover plates for device boxes.
5. Hoods for outlet boxes.

B. Shop Drawings:
1. Shop drawings for floor boxes.

PART 2 - PRODUCTS

2.1 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QCIT; including UL 514A.

B. Source Quality Control:
1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

C. UL QCIT - Metallic Outlet Boxes and Covers:
   1. Description: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.
   2. Options:
      a. Material: Sheet steel.
      b. Sheet Metal Depth: Minimum 2 inch.
      c. Cast-Metal Depth: Minimum 2.4 inch.
      d. Luminaire Outlet Boxes and Covers: Nonadjustable, listed and labeled for attachment of luminaire weighing up to 50 lb.
      e. Paddle Fan Outlet Boxes and Covers: Nonadjustable, designed for attachment of paddle fan weighing up to 70 lb.

D. UL QCIT - Metallic Conduit Bodies:
   1. Description: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.

E. UL QCIT - Metallic Device Boxes:
   1. Description: Box with provisions for mounting wiring device directly to box.
   2. Options:
      a. Material: Sheet steel.
      b. Sheet Metal Depth: minimum 2 inch.
      c. Cast-Metal Depth: minimum 2.4 inch.

F. UL QCIT - Metallic Extension Rings:
   1. Description: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both and to accommodate building finishes.

G. UL QCIT - Metallic Floor Boxes and Floor Box Covers:
   1. Description: Box mounted in floor with floor box cover and other components to complete floor box enclosure.
   2. Refer to the Drawings for additional information.

H. UL QCIT - Metallic Concrete Boxes and Covers:
   1. Description: Box intended for use in poured concrete.

2.2 NONMETALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
   2. Listing Criteria: UL CCN QCMZ; including UL 514C.

B. Source Quality Control:
   1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

C. UL QCMZ - Nonmetallic Outlet Boxes and Covers:
   1. Description: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.

D. UL QCMZ - Nonmetallic Conduit Bodies:
   1. Description: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.

E. UL QCMZ - Nonmetallic Device Boxes:
   1. Description: Box with provisions for mounting wiring device directly to box.

F. UL QCMZ - Nonmetallic Extension Rings:
   1. Description: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.

G. UL QCMZ - Nonmetallic Floor Boxes and Floor Box Covers:
   1. Description: Box mounted in floor with floor box cover and other components to complete floor box enclosure.

2.3 JUNCTION BOXES AND PULL BOXES

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
   2. Listing Criteria: UL CCN BGUZ; including UL 50 and UL 50E.

B. Source Quality Control:
   1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
   2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL BGUZ - Indoor Sheet Metal Junction and Pull Boxes:
   1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
   2. Options:
      a. Degree of Protection: Type 1 unless otherwise indicated.

D. UL BGUZ - Indoor Cast-Metal Junction and Pull Boxes:
   1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
   2. Options:
      a. Degree of Protection: Type 1 unless otherwise indicated.

E. UL BGUZ - Indoor Polymeric Junction and Pull Boxes:
   1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
   2. Options:
      a. Degree of Protection: Type 1 unless otherwise indicated.

F. UL BGUZ - Outdoor Sheet Metal Junction and Pull Boxes:
   1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
   2. Options:
      a. Degree of Protection: Type 3R unless otherwise indicated.

G. UL BGUZ - Outdoor Cast-Metal Junction and Pull Boxes:
   1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
   2. Options:
      a. Degree of Protection: Type 4 unless otherwise indicated.

H. UL BGUZ - Outdoor Polymeric Junction and Pull Boxes:
   1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
   2. Options:
      a. Degree of Protection: Type 3R unless otherwise indicated.

2.4 COVER PLATES FOR DEVICE BOXES

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
   2. Listing Criteria: UL CCN QCIT or UL CCN QCMZ; including UL 514D.
   3. Wallplate-Securing Screws: Metal with head color to match wallplate finish.

B. Source Quality Control:
   1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

C. UL QCIT or QCMZ - Metallic Cover Plates for Device Boxes:
   1. Options:
      a. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
      b. Wallplate Material: 0.032-inch-thick, Type 302/304 non-magnetic stainless steel with brushed finish or as indicated on architectural Drawings.

D. UL QCIT or QCMZ - Nonmetallic Cover Plates for Device Boxes:
   1. Options:
      a. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.

b. Wallplate Material: 0.060-inch-thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device.
c. Color: White or as indicated on architectural Drawings.

2.5 HOODS FOR OUTLET BOXES

A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. Listing Criteria:
a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.
b. Receptacle, Hood, Cover Plate, Gaskets, and Seals: UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.
3. Mounts to box using fasteners different from wiring device.

B. Source Quality Control:
1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

C. UL QCIT or QCMZ - Retractable or Reattachable Hoods for Outlet Boxes:
1. Options:
a. Provides clear, weatherproof, "while-in-use" cover.

PART 3 - EXECUTION

3.1 SELECTION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.

B. Degree of Protection:
1. Outdoors:
a. Type 3R unless otherwise indicated.
b. Locations Exposed to Hosedown: Type 4.
c. Locations Subject to Potential Flooding: Type 6P.
d. Locations Exposed to Corrosive Agents: Type 4X.
2. Indoors:
a. Type 1 unless otherwise indicated.
b. Damp or Dusty Locations: Type 12.
c. Surface Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: Type 12.
d. Flush Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: Type 12.
e. Locations Exposed to Hosedown: Type 4.
f. Locations Exposed to Corrosive Agents: Type 4X.

C. Exposed Boxes Installed Less Than 2.5 m (8 ft) Above Floor:
   1. Provide cast-metal boxes.

3.2 INSTALLATION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:
   1. Outlet, Device, Pull, and Junction Boxes: Article 314 of NFPA 70.
   2. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:
   1. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
   2. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements.
   3. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box, whether installed indoors or outdoors.
   4. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
   5. Locate boxes so that cover or plate will not span different building finishes.
   6. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
   7. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
   8. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
   9. Set metal floor boxes level and flush with finished floor surface.
   10. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
   11. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
   12. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
   13. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:
      a. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.
      b. Provide gaskets for wallplates and covers.
   14. Identification: Provide labels for boxes and associated electrical equipment.
      a. Identify field-installed conductors, interconnecting wiring, and components.
      b. Provide warning signs.
      c. Label each box with engraved metal or laminated-plastic nameplate.

3.3 CLEANING

A. Remove construction dust and debris from boxes before installing wallplates, covers, and hoods.

3.4 PROTECTION

A. After installation, protect boxes from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260533.16

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Type PVC raceways and fittings.
2. Fittings for conduit, tubing, and cable.
3. Electrically conductive corrosion-resistant compounds for threaded conduit.
4. Solvent cements.
5. Duct accessories.
6. Duct sealing.

1.2 ACTION SUBMITTALS

A. Product Data:
1. Duct-bank materials, including spacers and miscellaneous components.
2. Ducts, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Underground-line warning tape.

B. Shop Drawings:
1. Electric Utility Duct Banks and Structures:
   a. Include plans, elevations, sections, and details, including attachments to other Work.
   b. Indicate locations of private property boundaries and utility easements.
   c. Include information required for approval by electric utility and for obtaining public space utility work permits.
2. Precast or Factory-Fabricated Concrete Structures:
   a. Include plans, elevations, sections, and details, including attachments to other Work.
   b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.
   c. Include reinforcement details.
   d. Include frame and cover design and manhole chimneys.
   e. Include ladder details.
   f. Include grounding details.
   g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, sumps, and other accessories.
   h. Include joint details.

C. Field Quality-Control Submittals:
1. Field quality-control reports.

PART 2 - PRODUCTS

2.1 TYPE PVC RACEWAYS AND FITTINGS

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
   2. General Characteristics: UL 651 and UL CCN DZYR.

B. Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:
   1. Dimensional Specifications: Schedule 80.
   2. Options:
      a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
      b. Markings: For use with maximum 90 deg C wire and for directional boring applications.

2.2 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

B. Metallic Fittings for Type ERMC, Type IMC, Type PVC, Type EPEC, and Type RTRC Raceways:
   1. General Characteristics: UL 514B and UL CCN DWTT.
   2. Options:
      a. Material: Steel.
      b. Coupling Method: Compression coupling.
      c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
      d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

2.3 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
   2. General Characteristics: UL Subject 2419 and UL CCN FOIZ.

2.4 SOLVENT CEMENTS

A. Performance Criteria:
   1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
   2. General Characteristics: As recommended by conduit manufacturer in accordance with UL 514B and UL CCN DWTT.

2.5 DUCT ACCESSORIES

A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

B. Underground-Line Warning Tape: In accordance with Section 260553 "Identification for Electrical Systems."

2.6 DUCT SEALING

A. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Compound must be capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduit, conduit and duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals. Duct sealing compound must be removable without damaging ducts or cables.

B. Inflatable Duct-Sealing System: Wraparound inflatable bladder that seals ducts that are empty or containing conductors against air and water infiltration. System is suitable for use in steel, plastic, or concrete ducts and penetrations.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of duct, duct bank, and boxes with final arrangement of other utilities, site grading, and surface features as determined in field. Notify Architect if there is conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to handholes, and as approved by Architect.

3.2 SELECTION OF UNDERGROUND DUCTS

A. Duct for Electrical Feeders: PVC-80 or concrete encased unless otherwise indicated.

B. Duct for Electrical Branch Circuits: PVC-80, direct buried unless otherwise indicated.

C. Bored Underground Duct: EPEC-40 unless otherwise indicated.

D. Underground Ducts Crossing Paved Paths, Walks, and Driveways: PVC-80 or encased in reinforced concrete.

E. Stub-ups: Concrete encased, PVC-80.

3.3 EARTHWORK

A. Restoration: Restore area immediately after backfilling is completed or after construction vehicle traffic in immediate area is complete.

B. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.

3.4 INSTALLATION OF DUCTS AND DUCT BANKS

A. Reference Standards:
   1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA TCB 2 for installation of underground ducts and duct banks.
   2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:
   1. Where indicated on Drawings, install duct, spacers, and accessories into duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
   2. Slope: Pitch duct minimum slope of 1:300 down toward handholes and away from buildings and equipment.
   3. Expansion and Deflection Fittings: Install expansion and deflection fitting in each duct in area of disturbed earth adjacent to manhole or handhole.
   4. Install expansion fitting near center of straight line duct with calculated expansion of more than 3/4 inch.
   5. Curves and Bends:
      a. Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with minimum radius of 48 inch, both horizontally and vertically, at other locations unless otherwise indicated.
      b. Field bending must be in accordance with NFPA 70 minimum radii requirements, except bends over 45 degrees must be made with minimum radius of 48 inch. Use only equipment specifically designed for material and size involved. Use PVC heating bender for bending PVC conduit.
      c. Duct must have maximum of 180 degrees of bends between pull points.

6. Joints: Use solvent-cemented joints in nonmetallic duct and fittings and make watertight in accordance with manufacturer's published instructions. Stagger couplings so those of adjacent duct do not lie in same plane. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with minimum 3 inch of concrete for minimum of 12 inch on each side of coupling.
    a. Install insulated grounding bushings on steel raceway terminations that are less than 12 inch below grade or floor level and do not terminate in hubs.
7. Building Wall Penetrations: Make transition from underground duct to steel raceway at least 10 ft outside building wall, without reducing duct line slope away from building and without forming trap in line. Use fittings manufactured for transition to steel raceway type installed. Install steel raceway penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
8. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15 psig hydrostatic pressure.
9. Pulling Cord: Install 200 lbf test nylon cord in empty ducts.
10. Direct-Buried Duct and Duct Bank:
    a. Excavate trench bottom to provide firm and uniform support for duct.
    b. Width: Excavate trench 3 inch wider than duct on each side.
    c. Depth: Install top of duct at least 36 inch below finished grade unless otherwise indicated.
    d. Set elevation of top of duct bank below frost line.
    e. Place minimum 3 inch of sand as bed for duct. Place sand to minimum of 6 inch above top level of duct.
    f. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
    g. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 ft of duct. Place spacers within 24 inch of duct ends. Stagger spacers approximately 6 inch between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
    h. Install duct with minimum of 3 inch between ducts for like services and 6 inch between power and communications duct.
11. Underground-Line Warning Tape: Bury nonconducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inch above concrete-encased duct and duct banks and approximately 12 inch below grade. Align tape parallel to and within 3 inch of centerline of duct bank. Provide additional warning tape for each 12-inch increment of duct-bank width over nominal 18 inch. Space additional tapes 12 inch apart, horizontally across width of ducts.
12. Ground ducts and duct banks in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

3.5 FIELD QUALITY CONTROL

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide minimum 12-inch-long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.

B. Nonconforming Work:
1. Underground ducts, raceways, and structures will be considered defective if they do not pass tests and inspections.
2. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Assemble and submit test and inspection reports.

D. Manufacturer Services:
1. Engage factory-authorized service representative to support field tests and inspections.

END OF SECTION 260543

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Round sleeves.
   2. Sleeve-seal systems.
   3. Sleeve-seal fittings.
   4. Grout.
   5. Pourable sealants.
   6. Foam sealants.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

A. Steel Wall Sleeves:
   1. General Characteristics: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

B. PVC Pipe Sleeves:
   1. General Characteristics: ASTM D1785, Schedule 40.

C. Round, Galvanized-Steel, Sheet Metal Sleeves:
   1. General Characteristics: Galvanized-steel sheet; thickness not less than 0.0239 inch; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 SLEEVE-SEAL SYSTEMS

A. General Characteristics: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.

B. Options:
   1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Carbon steel.
   3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. General Characteristics: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit must have plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

A. General Characteristics: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
   1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
   2. Design Mix: 5000 psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

2.5 POURABLE SEALANTS

A. Performance Criteria:
   1. General Characteristics: Single-component, neutral-curing elastomeric sealants of grade indicated below.
      a. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2.6 FOAM SEALANTS

A. Performance Criteria:
   1. General Characteristics: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
      b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
   2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless sleeve-seal system is to be installed.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inch above finished floor level. Install sleeves during erection of floors.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for wall assemblies.

C. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve-seal systems. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

E. Underground, Exterior-Wall and Floor Penetrations:
1. Install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Install sleeve during construction of floor or wall.
2. Install steel pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Grout sleeve into wall or floor opening.

3.2 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION 260544

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Electrical identifications requirements.
2. Nameplates and labels.
3. Wire and cable markers.
4. Voltage markers.
5. Underground warning tape.
6. Warning signs and labels.
7. Identification schedule.
8. Fasteners for labels and signs.

1.2 COORDINATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70.

B. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

C. Comply with ANSI Z535.4 for safety signs and labels.

D. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

2.2 NAMEPLATES AND LABELS

A. Identification Nameplates:
   1. Materials:
      a. Indoors: Laminated acrylic or melamine plastic, two or three layer, electrically nonconductive with beveled edges; minimum thickness of 1/16-inch for nameplates having any dimension less than four inches; 1/8-inch for larger nameplates.
      b. Outdoors: Aluminum nameplates suitable for outdoor use; anodized, engraved or laser-etched text, minimum 1/32-inch thickness.
   2. Mounting holes for mechanical fasteners: Two centered on the sides for sizes up to 1-inch high nameplates; four at corners for larger sizes.

B. Identification Labels:
   1. Polyester or vinyl, self-adhesive, weather, chemical and UV-resistant for indoor use only.
   2. Text: Machine printed.

C. Equipment Identification Format:
   1. Minimize size: 1 inch by 2.5 inches.
   2. Legend: Equipment designation or other approved description.
   3. Text: All capitals, 1/2-inch minimum text height unless otherwise indicated.
   4. Color:
      a. Normal power system: White text on black background.
      b. Emergency power system: White text on red background.
      c. Fire alarm system: White text on red background.

D. General Information and Operating Instruction Format:
   1. Minimize size: 1 inch by 2.5 inches.
   2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
   3. Text: All capitals, 1/4-inch text height, unless otherwise indicated.
   4. Color: Black text on white background.

E. Caution and Warning Message Format:
   1. Minimize size: 2 inches by 4 inches.
   2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
   3. Text: All capitals, 1/2-inch text height, unless otherwise indicated.
   4. Color: Black text on yellow background unless otherwise indicated.

F. Receptacle/Switch Identification Format:
   1. Minimize size: 3/8 inch by 1.5 inches.
   2. Legend: Power source and circuit number or other designation indicated.
   3. Text: All capitals, 3/16-inch minimum text height unless otherwise indicated.
   4. Color: Black text on clear background.

G. Control Device Identification Format:
   1. Minimize size: 3/8 inch by 1.5 inches.
   2. Legend: Load controlled or other designation indicated.
   3. Text: All capitals, 3/16-inch minimum text height unless otherwise indicated.
   4. Color: Black text on clear background.

H. Fire Alarm Device Identification Format:
   1. Minimize size: 3/8 inch by 1.5 inches.
   2. Legend: Designation indicated and device zone or address.
   3. Text: All capitals, 3/16-inch minimum text height unless otherwise indicated.
   4. Color: Red text on white background.

2.3 WIRE AND CABLE MARKERS

A. Vinyl Wraparound Labels: Polyester or vinyl, self-adhesive, self-laminating markers, heat shrink sleeves, or split plastic sleeves suitable for the conductor or cable to which applied.

B. Legend: Power source and circuit number for power conductors and cables or other designation as appropriate for the system identified.

C. Text: Machine printed, all capitals, 1/8-inch height.

D. Color: Black text on white background unless otherwise indicated.

2.4 VOLTAGE MARKERS

A. Markers for Conduits: Provide preprinted, self-adhesive vinyl, vinyl cloth or vinyl snap around markers.

B. Markers for Boxes and Equipment Enclosures: Provide preprinted, self-adhesive vinyl or vinyl cloth markers.

C. Minimum Size:
   1. Equipment: 1-1/8 by 4-1/2 inches.
   2. Conduits: as recommended by the manufacturer for the conduit size.
   3. Pull boxes: 1-1/8 by 4-1/2 inches.
   4. Junction boxes: 1/2 by 2-1/4 inches.

D. Legend: Highest voltage present.

2.5 UNDERGROUND WARNING TAPE

A. Materials: Provide 3-inch-wide, non-detectable polyethylene tape suitable for direct burial with type of service continuously printed on one side of tape.
   1. Exception: Provide foil-backed detectable type tape where required by the serving utility or where directed by the Owner.

B. Legend: Type of service, continuously repeated over full length of tape.

C. Color:
   1. Black text on red background for underground power lines.
   2. Black text on orange background for underground communications, alarm and signal lines.

2.6 WARNING SIGNS AND LABELS

A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

B. Warning Signs:
   1. Preprinted baked enamel aluminum or galvanized steel backed butyrate signs, punched or drilled for fasteners, with colors, legend, and size required for application.
   2. 1/4-inch grommets in corners for mounting.
   3. Nominal Size: 7 by 10 inches.

C. Warning Labels:
   1. Pre-printed, polyester or vinyl, self-adhesive, weather, chemical and UV-resistant; material UL 969 recognized.
   2. Minimum size: 2 by 4 inches unless otherwise indicated.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 IDENTIFICATION SCHEDULE

A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.

B. Identification of Equipment:
   1. Use engraved identification nameplate to identify each piece of electrical distribution equipment and control equipment and associated sections, compartments and components.
      a. Switchboards, include the following:
         1) Voltage, phase and ampere rating
         2) Power source and circuit number. Include location when not within sight of equipment.
         3) Identify main and tie devices.
         4) Provide a nameplate to identify loads served for each feeder or branch device.
      b. Panelboards: include the following:
         1) Voltage, phase and ampere rating
         2) Power source and circuit number. Include location when not within sight of equipment.

3) Provide a nameplate to identify loads served for each feeder or branch device.
4) Provide main overcurrent protective device with a label. Use self-adhesive label in panelboards with a door and engraved nameplate on panelboards without a door.
5) Provide a machine printed circuit directory identifying loads served in panelboards with a door and engraved nameplates on panelboards without a door.

c. Transformers, include the following:
1) Primary and secondary voltage, phase and kVA rating
2) Power source and circuit number. Include location when not within sight of equipment.
3) Identify loads served; include location when not in sight of transformer.

d. Enclosed switches, circuit breakers and motor controllers; include the following:
1) Voltage and phase.
2) Power source and circuit number. Include location when not within sight of equipment.
3) Identify loads served; include location when not within sight of equipment.

2. Service Equipment: include the following:
a. Use engraved nameplate to identify each service disconnecting means.
b. Use engraved nameplate to identify location of remote disconnecting means.

3. Provide self-adhesive identification label or engraved nameplate inside door of each fusible switch to identify required NEMA fuse class and Ampere rating.

4. Working clearances: Use field painted floor markings, floor marking tape or self-adhesive warning labels where indicated or where required by the authority having jurisdiction.
a. Field painted floor markings: Alternating black and white stripes, 3-inches wide, painted in accordance with Division 09 requirements.

C. Identification of Conductors and Cables.
1. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
b. Colors for 208/120-V Circuits:
1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.
c. Colors for 240-V Circuits:
1) Phase A: Black.
2) Phase B: Red.
d. Color for Neutral: White or gray.
e. Color for Equipment Grounds: Green.
f. Colors for Isolated Grounds: Green with white stripe.

2. Provide wrap-around cable markers to identify circuit number or other designation indicated for power, control and instrumentation conductors and cables at the following locations:
    a. At each source and load location.
    b. Within boxes where more than one circuit is present.
    c. Within equipment enclosures when conductors or cables enter or leave the enclosure.
    d. Provide wrap-around wire and cable markers to identify connected grounding electrode conductors.

D. Identification of Raceways.
1. Provide voltage markers or color-coded bands to identify systems other than normal power for accessible conduits at maximum intervals of 20 feet.
    a. Color-coded bands: Use field painting or vinyl color coding electrical tape to mark bands 3-inches wide.
        1) Color code:
            a) Emergency power system: Red.
            b) Fire alarm system: Red.
            c) Fire suppression supervisory and control system: Red and yellow.
            d) Combined fire alarm and security system: Red and blue.
            e) Security system: Blue and yellow.
            f) Mechanical and electrical supervisory system: Green and blue.
            g) Communications system: green and yellow.
            h) Control wiring: green and red.
        2) Field painting: Comply with Division 09 requirements.
2. Provide underground warning tape to identify direct buried or concrete encased underground raceways. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade.

E. Identification of Boxes.
1. Provide voltage markers or color coded boxes or box covers to identify systems other than normal power.
    a. Color coded boxes or box covers: Field-painted in accordance with Division 09 requirements using the same color code as noted above.
2. Provide self-adhesive identification labels or hand write text using indelible marker to identify circuits enclosed.

F. Identification of Devices:
1. Wiring device and wall plate finishes: Comply with Section 260533.16
2. Provide self-adhesive or engraved wall plate to identify service branch circuit for all receptacles.
    a. For receptacles in public spaces or in area as directed by the Architect, provide identification on the inside surface of the faceplate.
3. Provide self-adhesive identification label to identify fire alarm system devices.
    a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device.

4. Provide self-adhesive identification label or engraved wall plate to identify load controller for wall mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.
5. Provide self-adhesive identification labels to identify receptacles protected by upstream ground fault circuit interrupters.

G. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

END OF SECTION 260553

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Molded-case circuit breakers (MCCBs).
   4. Enclosures.

B. Related Requirements:
   1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:
   1. For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   2. Enclosure types and details for types other than UL 50E, Type 1.
   3. Current and voltage ratings.
   4. Short-circuit current ratings (interrupting and withstand, as appropriate).
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
   6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in electronic format.

1.3 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: Furnish to Owner spare parts, for repairing enclosed switches and circuit breakers, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Fuse Pullers: Two for each size and type.

1.5 WARRANTY

A. Warranty: Manufacturer and Installer warrants that fabricated and installed enclosed switches and circuit breakers perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.
   1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Source Limitations: Obtain products from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 FUSIBLE SWITCHES

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. ABB, Electrification Business.
   2. Eaton.
   3. Siemens Industry, Inc., Energy Management Division.
   4. Square D; Schneider Electric USA.

B. Type HD, Heavy Duty:
   1. Single throw unless otherwise indicated.
   2. Three pole unless otherwise indicated.
   3. 240 V(ac) for 120/208V and 120/240V systems; 600 V(ac) for 277/480V systems.
   4. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified or indicated fuses.
   5. Lockable handle with capability to accept three 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: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Service-Rated Switches: Labeled for use as service equipment.
5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 NONFUSIBLE SWITCHES

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. ABB, Electrification Business.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.

B. Type HD, Heavy Duty, Three Pole, Single Throw, 240 or 600 V(ac) as required, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three 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: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Service-Rated Switches: Labeled for use as service equipment.
5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 MOLDED-CASE CIRCUIT BREAKERS

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. ABB, Electrification Business.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.

B. Circuit breakers must be constructed using glass-reinforced insulating material. Current carrying components must be completely isolated from handle and accessory mounting area.

C. Circuit breakers must have toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. Circuit-breaker handle must be over center, be trip free, and reside in tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon must be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with push-to-trip button, located on face of circuit breaker to mechanically operate circuit-breaker tripping mechanism for maintenance and testing purposes.

D. Maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings must be clearly marked on face of circuit breaker. Circuit breakers must be 100 percent rated.

E. MCCBs must be equipped with device for locking in isolated position.

F. Lugs must be suitable for 75 deg C rated wire.

G. Standard: Comply with UL 489 with required interrupting capacity for available fault currents.

H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal 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.

I. Features and Accessories:
   1. Standard frame sizes, trip ratings, and number of poles.
   2. Application Listing: Appropriate for application.
   3. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, UL 50E, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: Enclosure must be finished as follows:
   1. UL 50E, Type 1: Gray baked enamel paint, electrodeposited on cleaned, phosphatized steel.
   2. UL 50E, Type 3R, 12: Gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel.
   3. UL 50E Type 4-4X stainless steel: A brush finish on Type 304 stainless steel.

C. Conduit Entry: UL 50E Types 4, 4X, and 12 enclosures may not contain knockouts. UL 50E.

D. Operating Mechanism:
   1. UL 50E Type 1: Circuit-breaker operating handle must be externally operable with operating mechanism being integral part of box, not cover directly operable through front cover of enclosure.
   2. UL 50E Type 3R, 4, 4X, 12: Directly operable through dead front trim of enclosure.
   3. UL 50E, Types 7, 9: Externally operable with operating mechanism being integral part of cover.
   4. Cover interlock mechanism must have externally operated override. Override may not permanently disable interlock mechanism, which must return to locked position once override is released. Tool used to override cover interlock mechanism must not be required to enter enclosure in order to override interlock.

E. Enclosures designated as UL 50E Type 4, 4X stainless steel, 12, or 12K must have dual cover interlock mechanism to prevent unintentional opening of enclosure cover when circuit breaker is ON and to prevent turning circuit breaker ON when enclosure cover is open.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
   1. Commencement of work will indicate Installer's acceptance of areas and conditions as satisfactory.

3.2 SELECTION OF ENCLOSURES

A. Indoor, Dry and Clean Locations: UL 50E, Type 1.

B. Outdoor Locations: UL 50E, Type 3R.

C. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E, Type 12.

3.3 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Special Techniques:
   1. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

2. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
3. Install fuses in fusible devices.

3.4 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges to values indicated on Drawings.

3.6 PROTECTION

A. After installation, protect enclosed switches and circuit breakers from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 262816

SECTION 284621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Existing fire-alarm system to be modified.
   2. Addressable fire-alarm system.
   3. System smoke detectors.
   4. Fire-alarm notification appliances.

B. Related Requirements:
   1. Section 087100 "Door Hardware" for magnetic door holders that release in response to fire-alarm outputs.
   2. Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1.3 DEFINITIONS

A. DACT: Digital alarm communicator transmitter.

B. EMT: Electrical metallic tubing.

C. FACU: Fire-alarm control unit.

D. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the 2007 Energy Independence and Security Act (EISA).

E. NICET: National Institute for Certification in Engineering Technologies.

F. PC: Personal computer.

G. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:
   1. Control Voltage: Listed and labeled for use in remote-control, signaling, and power-limited circuits supplied by a Class 2 or Class 3 power supply having rated output not greater than 150 V and 5 A, allowing use of alternate wiring methods complying with NFPA 70, Article 725.
   2. Low Voltage: Listed and labeled for use in circuits supplied by a Class 1 or other power supply having rated output not greater than 1000 V, requiring use of wiring methods complying with NFPA 70, Article 300, Part I.

1.4 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. When new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from building.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.5 ACTION SUBMITTALS

A. Approved Permit Submittal: Submittals must be approved by authorities having jurisdiction prior to submitting them to Architect.

B. Product Data: For each type of product, including furnished options and accessories.
   1. Include construction details, material descriptions, dimensions, profiles, and finishes.
   2. Include rated capacities, operating characteristics, and electrical characteristics.

C. Shop Drawings: For fire-alarm system.
   1. Comply with recommendations and requirements in "Documentation" section of "Fundamentals" chapter in NFPA 72.
   2. Include plans, elevations, sections, and details, including details of attachments to other Work.
   3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
   4. Annunciator panel details as required by authorities having jurisdiction.
   5. Detail assembly and support requirements.
   6. Include voltage drop calculations for notification-appliance circuits.
   7. Include battery-size calculations.
   8. Include input/output matrix.
   9. Include written statement from manufacturer that equipment and components have been tested as a system and comply with requirements in this Section and in NFPA 72.
   10. Include performance parameters and installation details for each detector.
   11. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
   12. Provide control wiring diagrams for fire-alarm interface to HVAC; coordinate location of duct smoke detectors and access to them.
      a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
      b. Show field wiring and equipment required for HVAC unit shutdown on alarm.
      c. Locate detectors in accordance with manufacturer's written instructions.

13. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
14. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:
      a. Comply with "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
      b. Provide "Fire-Alarm and Emergency Communications System Record of Completion Documents" in accordance with "Completion Documents" Article in "Documentation" section of "Fundamentals" chapter in NFPA 72.
      c. Complete wiring diagrams showing connections between devices and equipment. Each conductor must be numbered at every junction point with indication of origination and termination points.
      d. Riser diagram.
      e. Device addresses.
      f. Record copy of site-specific software.
      g. Provide "Inspection and Testing Form" in accordance with "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
         1) Equipment tested.
         2) Frequency of testing of installed components.
         3) Frequency of inspection of installed components.
         4) Requirements and recommendations related to results of maintenance.
         5) Manufacturer's user training manuals.
      h. Manufacturer's required maintenance related to system warranty requirements.
      i. Abbreviated operating instructions for mounting at FACU and each annunciator unit.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: 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 Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
   2. Smoke Detectors, Heat Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
   3. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.

4. Keys and Tools: One extra set for access to locked or tamperproofed components.
5. Audible and Visual Notification Appliances: One of each type installed.
6. Fuses: Two of each type installed in system. Provide in box or cabinet with compartments marked with fuse types and sizes.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Personnel must be trained and certified by manufacturer for installation of units required for this Project.
   2. Licensed or certified by authorities having jurisdiction.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail because of defects in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 EXISTING FIRE-ALARM SYSTEM TO BE MODIFIED

A. Basis for Pricing: National Time and Signal Corporation.

B. Description: Add devices indicated on drawings to existing fire alarm system.

C. Source Limitations for Fire-Alarm System and Components: Components must be compatible with, and operate as extension of, existing system. Provide system manufacturer's certification that components provided have been tested as, and will operate as, a system.

2.2 SYSTEM SMOKE DETECTORS

A. Photoelectric Smoke Detectors:
   1. Performance Criteria:
      a. Regulatory Requirements:
         1) NFPA 72.
         2) UL 268.
      b. General Characteristics:
         1) Detectors must be two-wire type.
         2) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
         3) Base Mounting: Detector and associated electronic components must be mounted in twist-lock module that connects to fixed base. Provide terminals in fixed base for connection to building wiring.
         4) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.

5) Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
6) Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
7) Operator at FACU, having designated access level, must be able to manually access the following for each detector:
   a) Primary status.
   b) Device type.
   c) Present average value.
   d) Present sensitivity selected.
   e) Sensor range (normal, dirty, etc.).
8) Detector must have functional humidity range within 10 to 90 percent relative humidity.
9) Color: White.
10) Remote Control: Unless otherwise indicated, detectors must be digital-addressable type, individually monitored at FACU for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by FACU.
11) Multiple levels of detection sensitivity for each sensor.
12) Sensitivity levels based on time of day.

2.3 FIRE-ALARM NOTIFICATION APPLIANCES

A. Fire-Alarm Voice/Tone Notification Appliances:
   1. Description: Notification appliances capable of outputting voice evacuation messages.
   2. Performance Criteria:
      a. Regulatory Requirements:
         1) NFPA 72.
         2) UL 1480.
      b. General Characteristics:
         1) Speakers for Voice Notification: Locate speakers for voice notification to provide intelligibility requirements of "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
         2) High-Range Units: Rated 2 to 15 W.
         3) Low-Range Units: Rated 1 to 2 W.
         4) Mounting: Flush semi-recessed or surface mounted and bidirectional.
         5) Matching Transformers: Tap range matched to acoustical environment of speaker location.
         6) Combination Devices: Factory-integrated audible and visible devices in single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
   1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

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

3.2 PREPARATION

A. Preinstallation Testing: Perform verification of functionality of installed components of existing system prior to starting work. Document equipment or components not functioning as designed.

B. 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 in accordance with requirements indicated:
   1. Notify Owner no fewer than seven 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.

C. Protection of In-Place Conditions: Protect devices during construction unless devices are placed in service to protect facility during construction.

3.3 INSTALLATION OF EQUIPMENT

A. Comply with NECA 305, NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
   1. Devices placed in service before other trades have completed cleanup must be replaced.
   2. Devices installed, but not yet placed, in service must be protected from construction dust, debris, dirt, moisture, and damage in accordance with manufacturer's written storage instructions.

B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
   1. Connect new equipment to existing control panel in existing part of building.

2. Connect new equipment to existing monitoring equipment at supervising station.
3. Expand, modify, and supplement existing control equipment as necessary to extend existing control functions to new points. New components must be capable of merging with existing configuration without degrading performance of either system.

C. Smoke-Detector Spacing:
1. Comply with "Smoke-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Smooth ceiling spacing must not exceed 30 ft.
3. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas must be determined in accordance with Annex A or Annex B in NFPA 72.
4. Lighting Fixtures: Locate detectors not closer than 12 inch from lighting fixture and not directly above pendant mounted or indirect lighting.

D. Install cover on each smoke detector that is not placed in service during construction. Cover must remain in place except during system testing. Remove cover prior to system turnover.

E. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within dwelling or suite, they must be connected so that operation of smoke alarm causes alarm in smoke alarms to sound.

F. Audible Alarm-Indicating Devices: Install not less than 6 inch below ceiling. Install bells and horns on flush-mounted back boxes with device-operating mechanism concealed behind grille. Install devices at same height unless otherwise indicated.

G. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inch below ceiling. Install devices at same height unless otherwise indicated.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
1. Nameplate must be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

3.6 PATHWAYS

A. Pathways above recessed ceilings and in inaccessible locations may be routed exposed.
   1. Exposed pathways located less than 96 inch above floor must be installed in EMT.

B. Exposed pathways must be installed in EMT.

C. Exposed EMT must be painted red enamel.

3.7 CONNECTIONS

A. Make addressable connections with supervised interface device to the following devices and systems. Install interface device less than 36 inch from device controlled. Make addressable confirmation connection when such feedback is available at device or system being controlled.
   1. Alarm-initiating connection to smoke-control system (smoke management) at firefighters' smoke-control system panel.
   2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
   3. Alarm-initiating connection to activate emergency lighting control.
   4. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
   5. Supervisory connections at fire-extinguisher locations.
   6. Supervisory connections at fire-pump power failure including dead-phase or phase-reversal condition.
   7. Supervisory connections at fire-pump engine control panel.

3.8 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."

B. Install framed instructions in location visible from FACU.

3.9 GROUNDING

A. Ground FACU and associated circuits in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Ground shielded cables at control panel location only. Insulate shield at device location.

3.10 FIELD QUALITY CONTROL

A. Administrant for Tests and Inspections:
   1. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:
   1. Visual Inspection: Conduct visual inspection prior to testing.
      a. Inspection must be based on completed record Drawings and system documentation that is required by "Completion Documents, Preparation" table in "Documentation" section of "Fundamentals" chapter in NFPA 72.
      b. Comply with "Visual Inspection Frequencies" table in "Inspection" section of "Inspection, Testing and Maintenance" chapter in NFPA 72; retain "Initial/Reacceptance" column and list only installed components.
   2. System Testing: Comply with "Test Methods" table in "Testing" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
   3. Test audible appliances for public operating mode in accordance with manufacturer's written instructions. Perform test using portable sound-level meter complying with Type 2 requirements in ASA S1.4 Part 1/IEC 61672-1.
   4. Test audible appliances for private operating mode in accordance with manufacturer's written instructions.
   5. Test visible appliances for public operating mode in accordance with manufacturer's written instructions.
   6. Factory-authorized service representative must prepare "Fire Alarm System Record of Completion" in "Documentation" section of "Fundamentals" chapter in NFPA 72 and "Inspection and Testing Form" in "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.

C. Reacceptance Testing: Perform reacceptance testing to verify proper operation of added or replaced devices and appliances.

D. Fire-alarm system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system. Provide video recording of training to Owner.

END OF SECTION 284621.11

THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK
WHITE
BLACK
WE RECYCLE

RENOVATIONS FOR:

LANSING SCHOOL DISTRICT

AVERILL NEW TECH ELEMENTARY MECHANICAL IMPROVEMENTS

3201 AVERILL DR., LANSING, MI 48911

PROJECT NUMBER: 22-0117

LANSING SCHOOL DISTRICT BOND: SB-0051

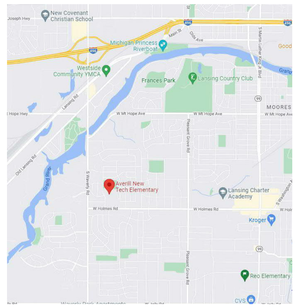
ISSUE DATE: 11-NOV-2022

CONSTRUCTION DOCUMENTS

N W E S

LOCATION MAP

NO SCALE



N W E S

VICINITY MAP

NO SCALE

811

Know what's **below.**
Call before you dig.

IT IS UNDERSTOOD THAT THE CONTRACTOR SHALL PERFORM ALL WORK UNDER THIS CONTRACT IN ACCORDANCE WITH ALL APPLICABLE PROVISIONS, POLICIES, RULES AND STANDARDS OF THE MICHIGAN OCCUPATIONAL SAFETY AND HEALTH ACT (MIOSHA), BEING ACT 154 OF THE PUBLIC ACTS OF 2013 AND AS AMENDED.

EXCEPT WHERE OTHERWISE INDICATED ON THE PLANS OR IN THE PROPOSAL SUPPLEMENTAL SPECIFICATIONS CONTAINED THEREIN, ALL MATERIALS AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE APPLICABLE SECTIONS OF THE MICHIGAN DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR CONSTRUCTION, 2012 EDITION, AND THE CURRENT SUPPLEMENTAL SPECIFICATIONS. (AVAILABLE AT WWW.MDOT.JBOSS.STATE.MI.US/SPECPROV/SPECBOOKHOME.HTM#1468271)

THROUGHOUT THE DRAWING SET, THE GRAYSCALE LEGEND ON THE EDGE OF TITLE BLOCKS SHOULD TRANSITION FROM WHITE THROUGH EIGHT SHADES OF GRAY TO SOLID BLACK. IF THE GRAYSCALE SHADES ARE NOT DISTINCT, THE DRAWING(S) HAVE NOT PRINTED CORRECTLY.

Lansing School District

SHEET NO.	SHEET NAME
GENERAL	
G-001	COVER SHEET
ARCHITECTURAL	
A-001	ARCHITECTURAL LEGENDS, SYMBOLS, AND ABBREVIATIONS
A-002	STRUCTURAL DETAILS
AD101A	DEMOLITION PLAN - AREA A
AD101B	DEMOLITION PLAN - AREA B
A-101A	FLOOR PLAN - AREA A
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A-111A	REFLECTED CEILING PLAN - AREA A
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A-201	ELEVATIONS & DETAILS
MECHANICAL	
M-001	MECHANICAL LEGENDS
MD101A	DEMOLITION PLAN - FIRST LEVEL - AREA A
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MH101A	HVAC PLAN - FIRST LEVEL - AREA A
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MP101A	PIPING PLAN - FIRST LEVEL - AREA A
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M-501	MECHANICAL DETAILS
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ELECTRICAL	
E-001	GENERAL NOTES AND LEGENDS
ED101A	DEMOLITION PLAN - AREA A
ED101B	DEMOLITION PLAN - AREA B
EP101A	ELECTRICAL PLAN - AREA A
EP101B	ELECTRICAL PLAN - AREA B
TOTAL SHEETS: 24	

REVISIONS		
REV	DESCRIPTION	DATE

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COVER SHEET

PROJ. #: 22-0117

DATE: 11-NOV-2022

SHEET

G-001

CONSTRUCTION DOCUMENTS

THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK

WHITE

WE RECYCLE

ABBREVIATIONS

ABBREV.	FULL TEXT
AB	ANCHOR BOLT
ABI	ADDITIVE BID ITEM
AC	ACOUSTICAL
ACB	ACOUSTICAL CEILING BAFFLE
ACP	ACOUSTICAL CEILING PANEL
ACS	ACOUSTICAL CEILING SPRAY
AD	AREA DRAIN
ADA	ADA
AFF	ABOVE FINISHED FLOOR
AL	ALUMINUM
ALUM	ALUMINUM
AP	ACCESS DOORS
APPROX	APPROXIMATE
ARCH	ARCHITECTURAL
ASPH	ASPHALT
AWP	ACOUSTICAL WALL PANEL
B/	BOTTOM OF
BD	BOARD
BF	BARRIER FREE
BIT	BITUMINOUS
BL	BUILDING LINE
BLDG	BUILDING
BLKHD	BULKHEAD
BOTT	BOTTOM
BP	BASE PLATE
BR	BUMP RAIL
BS	BOTH SIDES
BUR	BUILT UP ROOFING
CAB	CABINET
CB	CATCH BASIN
CEM	CEMENT
CG	CORNER GUARD
CH	CHANNEL
CHKDPL	CHECKERED PLATE
CJ	CONTROL JOINT
CL	CENTERLINE
CL TO CL	CENTERLINE TO CENTERLINE
CLG	CEILING
CLK	CAULKING
CLR	CLEAR
CMU	CONCRETE MASONRY UNIT
CO	CLEAN OUT
COL	COLUMN
COMP	COMPRESSIBLE
COMPO	COMPOSITION
CONC	CONCRETE
CONN	CONNECT, CONNECTION
CONST	CONSTRUCTION
CONST JT	CONSTRUCTION JOINT
CONT	CONTINUOUS
CONTR	CONTRACTOR
CPT	CARPET TILE
CS	CONCRETE SEALER
CTR	COUNTER
CTSK	COUNTERSINK
DEXS	DOUBLE EXTRA STRONG (STEEL PIPE)
DF	DRINKING FOUNTAIN
DIA	DIAMETER
DIFF	DIFFUSER
DN	DOWN
DO	DOOR OPENING
DR	DOOR
DS	DOWN SPOUT
DT	DRAIN TILE
DTL	DETAIL
DWG	DRAWING
DWR	DRAWER
E	EAST
EA	EACH
EIFS	EXTERIOR INSULATION AND FINISH SYSTEMS
EJ	EXPANSION JOINT
EL	ELEVATION
ELECT	ELECTRICAL
ELEV	ELEVATOR OR ELEVATION
ENCL	ENCLOSURE
EP	EPOXY PAINT
EPS	EXTERIOR PAINT SYSTEM
EQ	EQUAL
EQUIP	EQUIPMENT
ES	EXPOSED STRUCTURE
EW	EACH WAY
EWC	ELECTRICAL WATER COOLER
EX	EXISTING

ABBREVIATIONS

ABBREV.	FULL TEXT
EXGR	EXISTING GRADE
EXP	EXPANSION
EXS	EXTRA STRONG (STEEL PIPE)
EXT	EXTERIOR
FA	FIRE ALARM
FAB	FABRIC/UPHOLSTERY
FD	FLOOR DRAIN
FDN	FOUNDATION
FE	FIRE EXTINGUISHER
FEC	FIRE EXTINGUISHER CABINET
FG	FROSTED GLASS
FHC	FIRE HOSE CABINET
FIN	FINISH
FL	FLOOR
FLL	FLOOR LINE
FLUOR	FLUORESCENT
FOC	FACE OF COLUMN
FOCONC	FACE OF CONCRETE
FRC	FIBER REINFORCED CONCRETE
FRP	FIELD REINFORCED PANEL
FRPFG	FIREPROOFING
FS	FULL SIZE
FT	FIRE TREATED
FTG	FOOTING
FUR	FURRING
FV	FIELD VERIFY
G.B.	GRAB BAR, GRADE BEAM
G.O.	GRILL OPENING
GA	GAUGE
GALV	GALVANIZED
GCT	GLAZED CERAMIC TILE
GFCI	GROUND FAULT CIRCUIT INTERRUPTER
GL	GLASS
GND.	GROUND
GR.	GRADE
GRTG.	GRATING
GSCFT	GLAZED STRUCTURAL CLAY FACING TILE
GT	GROUT
GYP. BD.	GYPSUM BOARD
HC	HOLLOW CORE
HCWD	HOLLOW CORE WOOD
HDPB	HIGH DENSITY PARTICLEBOARD
HM	HOLLOW METAL
HORIZ	HORIZONTAL
HP	HIGH POINT
HR	HOUR
HT	HEIGHT
HWD	HARDWARE
I.D. OR ID	INSIDE DIAMETER
I.E.	INVERT ELEVATION
IG	INSULATING GLASS
IN	INCHES
INCL	INCLUDING, INCLUSIVE
INSUL	INSULATION
INT	INTERIOR
IPS	INTERIOR PAINT SYSTEM
JAN	JANITOR
JT	JOINT
kW	KILOWATTS
kWh	KILOWATT HOURS
LAD	LADDER
LAM	LAMINATED
LAV	LAVATORY
LF	LINEAR FEET
LGTH	LENGTH
LH	LEFT HAND
LKR	LOCKER
LLH	LONG LEG HORIZONTAL
LLV	LONG LEG VERTICAL
LO	LOUVER OPENING
LP	LIGHTING PANEL
LPG	LIQUID PETROLEUM GAS
LPS	LOW PRESSURE STEAM
LT	LIGHT
LWT	LEAVING WATER TEMPERATURE
MA	MEDICAL AIR
MANUF	MANUFACTURER
MAS	MASONRY
MATL	MATERIAL
MAX	MAXIMUM
MBH	THOUSAND BTU/HR
MC	MEDICINE CABINET
MCA	MINIMUM CIRCUIT AMPACITY
MCC	MULTI-COLOR COATING

ABBREVIATIONS

ABBREV.	FULL TEXT
MDO	MEDIUM DENSITY OVERLAY
MECH	MECHANICAL
MEMBWP	MEMBRANE WATERPROOFING
MET	METAL
MEZZ	MEZZANINE
MFR	MANUFACTURER
MFS	MAXIMUM FUSE SIZE
MG	MEDICAL GAS
MH	MANHOLE
MHP	MOTOR HORSEPOWER
MIN.	MINIMUM
MIRR	MIRROR
MISC	MISCELLANEOUS
MM	MISCELLANEOUS METALS
MO	MASONRY OPENING
MOCP	MAXIMUM OVERCRRENT PROTECTION
MPC	MICHIGAN PLUMBING CODE
MR	MANUFACTURER'S RECOMMENDATIONS
MT	MARBLE TILE
MTD	MOUNTED
MUL.	MULLION
N	NORTH
N.S.	NEAR SIDE
NF	NO FINISH
NIC	NOT IN CONTRACT
NO	NUMBER
NPSH	NET POSITIVE SUCTION HEAD
NSNS	NON SHRINK NON STAIN GROUT
NTS	NOT TO SCALE
NTS	NOT TO SCALE
O.C. OR OC	ON CENTER
OBSGL	OBSCURE GLASS
OD	OUTSIDE DIAMETER
OHDR	SECTIONAL OVERHEAD DOOR
OPNG	OPENING
OPP	OPPOSITE
P	PAINT
PART	PARTITION
PB	PARTICLE BOARD
PC	PRECAST
PCS	PIECES
PERM	PERMANENT
PL	PLATE
PLAM	PLASTIC LAMINATE
PLAS	PLASTER
PLBG	PLUMBING
PLY	PLYWOOD
PT	PRESSURE TREATED
PT	PORCELAIN TILE
PTB	PORCELAIN TILE BASE
QT	QUARRY TILE
QTB	QUARTZ TILE BASE
QTZ	QUARTZ
R	RISER
RA	RETURN AIR
RB	RUBBER BASE
RC	ROOF CONDUCTOR
RD	ROOF DRAIN
RD	ROUND
RECVG	RECEIVING
REF	REFRIGERATOR
REINF	REINFORCED
REQ'D	REQUIRED
RF	RESILIENT FLOORING
RH	RIGHT HAND
RL	ROOF LADDER
RM	ROOM
RO	ROUGH OPENING
RS	ROOF SUMP
RSN	RESIN
RWD	REDWOOD
RWD	RIGID WALL PROTECTION
S	SOUTH
S	SPANDREL GLASS
SA	SUPPLY AIR
SAB	SOUND ATTENUATION BLANKETS
SC	SOLID CORE
SCH	SCHEDULE
SCONC	SEALED CONCRETE
SCWD	SOLID CORE WOOD
SECT	SECTION
SER.RECPT	SERVICE RECEPTOR
SH	SHELF
SHT	SHEET

ABBREVIATIONS

ABBREV.	FULL TEXT
SHWR	SHOWER
SIM	SIMILAR
SLR	CONCRETE SEALER
SLS	SOLID SURFACE
SLV	SHORT LEG VERTICAL
SPEC	SPECIFICATION
SQ	SQUARE
SQFT	SQUARE FOOT
SS	STAINLESS STEEL
SSK	SERVICE SINK
SSM	SOLID SURFACING MATERIAL
ST	SMOKE-TIGHT PER CODE TO RESIST THE PASSAGE OF SMOKE
STD	STANDARD
STDW	STANDARD WEIGHT (STEEL PIPE)
STL	STEEL
STN	STAIN
STOR	STORAGE
STRL	STRUCTURAL
SUPP	SUPPORT
SUSP	SUSPENDED
SYM	SUSPENSION SYMMETRICAL
T	TREAD
T&G	TONGUE AND GROOVE
T.O.C. OR T/C	TOP OF CONCRETE
T.O.F. OR T/F	TOP OF FOOTING
T.O.M. OR T/M	TOP OF MASONRY
T.O.P. OR T/P	TOP OF PAVEMENT
T.O.S. OR T/S	TOP OF STEEL
T.O.W. OR T/W	TOP OF WALL
T/	TOP OF
TB	TRUSS BEARING
TG	TEMPERED GLASS
THK	THICK
THRESH	THRESHOLD
TLT	TOILET
TP	TOILET PARTITION
TR	TRANSITION TRIM
TYP	TYPICAL
TYP	TYPICAL
UNF	UNFINISHED
UNO	UNLESS NOTED OTHERWISE
UR	URINAL
VCT	VINYL COMPOSITION TILE
VERT	VERTICAL
VEST	VESTIBULE
VIF	VERIFY IN FIELD
W	WEST
W/	WITH
W/O	WITHOUT
WC	WATER CLOSET
WC	WALLCOVERING
WCO	WALL CLEAN OUT
WCVR	WALLCOVERING
WD	WOOD
WP	WATERPROOFING
WP	WORKPOINT
WP	WALL PROTECTION
WS	WINDOW SHADE
WSCT	WAINSCOT
WT	WEIGHT
X-(MATERIAL)	DENOTES EXISTING MATERIAL REFRENCED

DRAWING REFERENCE SYMBOLS

ENLARGED PLAN OR DETAIL — ARCHITECTURAL KEYNOTE

WALL SECTION — EQUIPMENT TAG

BUILDING SECTION — WALL TAG

EXTERIOR ELEVATIONS — DOOR TAG

INTERIOR ELEVATIONS — ROOM TAG

REVISION CLOUD AND TAG — WINDOW TAG

VIEW TITLE & REFERENCE — CEILING SPOT ELEVATION

DETAIL — FINISH TAG

EXISTING COLUMN LINE — SPECIALITY EQUIPMENT TAG

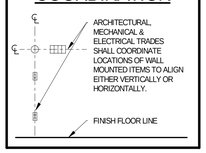
NEW COLUMN LINE — FURNITURE TAG

DEMO KEYNOTE

LEVEL OR ELEVATION

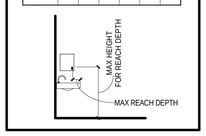
DEMARCATION LINE

MOUNTING HEIGHT COORDINATION

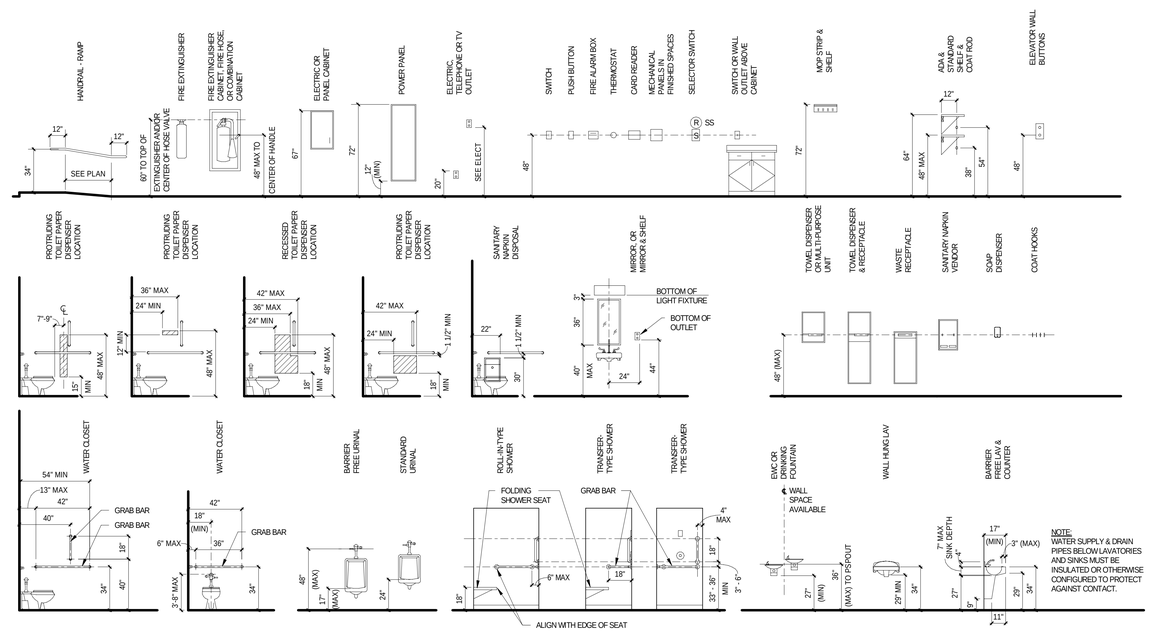


GENERAL MAXIMUM REACH DEPTH AND HEIGHT FOR HAND DRYERS / TOWEL DISPENSERS

MAX REACH DEPTH	0.5"	2"	5"	6"	9"	11"
MAX REACH HEIGHT	48"	46"	42"	40"	36"	34"



RECOMMENDED MOUNTING HEIGHTS (UNLESS OTHERWISE NOTED)



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ARCHITECTURAL LEGENDS, SYMBOLS, AND ABBREVIATIONS

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0117

DATE: 11-NOV-2022

SHEET

A-001

CONSTRUCTION DOCUMENTS

THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK
WHITE
WE RECYCLE

GENERAL STRUCTURAL NOTES

1. IT IS THE CONTRACTOR'S RESPONSIBILITY TO VERIFY ALL DIMENSIONS AND CONDITIONS AT THE JOB SITE AND TO CROSS-CHECK DETAILS AND DIMENSIONS ON THE STRUCTURAL DRAWINGS WITH THE RELATED REQUIREMENTS ON THE ARCHITECTURAL, MECHANICAL, ELECTRICAL, AND PLUMBING PLANS. FLOOR AND WALL OPENINGS, SLEEVES AND OTHER ARCH., MECH., ELEC., REQUIREMENTS MUST BE COORDINATED BEFORE THE CONTRACTOR PROCEEDS WITH CONSTRUCTION.
2. ALL ENGINEERING DESIGN, CONSTRUCTION, AND TESTING SHALL CONFORM TO THE REQUIREMENTS OF THE MOST RECENT EDITION OF THE MICHIGAN BUILDING CODE.
3. ALL STRUCTURAL WORK MUST BE TEMPORARILY BRACED AND SUPPORTED UNTIL THE STRUCTURE IS SUFFICIENTLY COMPLETED AND CAN SAFELY CARRY THE DESIGN AND CONSTRUCTION LOADS.
4. ALL OMISSIONS OR CONFLICTS BETWEEN THE VARIOUS ELEMENTS OF THE WORKING DRAWINGS AND/OR SPECIFICATIONS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER BEFORE PROCEEDING WITH ANY WORK THAT IS INVOLVED IN THE CONFLICT.

STRUCTURAL DESIGN INFORMATION:
DESIGN DATA BASED ON ASCE 7-16
RISK CATEGORY III

1. SNOW LOAD:
   - SNOW EXPOSURE FACTOR (Ce) 1.0
   - THERMAL FACTOR (Ct) 1.0
   - SNOW IMPORTANCE FACTOR (Is) 1.1
   - GROUND SNOW LOAD (Pg) 30 PSF
   - FLAT ROOF SNOW LOAD (Pf) 23.1 PSF
2. LIVE LOAD:
   - CONSTRUCTION 25 PSF
3. WIND LOADS:
   - BASIC WIND SPEED 114 MPH
   - WIND IMPORTANCE FACTOR (Iw) 1.00
   - WIND EXPOSURE CATEGORY 'B'
5. SEISMIC LOADS:
   - SEISMIC IMPORTANCE FACTOR (Ie) 1.25
   - SITE CLASS 'D'
   - SEISMIC DESIGN CATEGORY 'B'

STRUCTURAL STEEL:

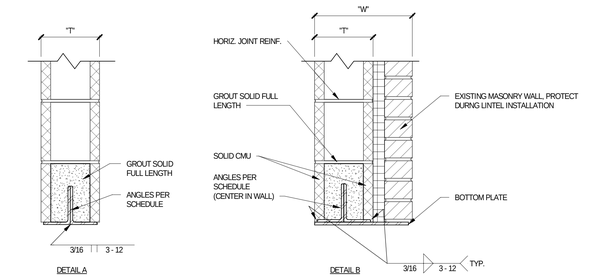
1. MATERIAL STANDARDS:
   - ANGLE, CHANNELS, PLATES ASTM A36 Fy = 36,000 PSI
2. STRUCTURAL AND MISC. STEEL SHALL BE DETAILED, FABRICATED AND ERECTED IN ACCORDANCE WITH THE MOST RECENT EDITION OF AISC STEEL CONSTRUCTION MANUAL AND CODE OF STANDARD PRACTICE.
3. WELDING SHALL BE DONE IN ACCORDANCE WITH THE "AMERICAN WELDING SOCIETY" (AWS) D1.1, USING E70 ELECTRODES. WELDING SHALL BE PERFORMED BY AN APPROVED CERTIFIED WELDER.
4. NO CHANGES SHALL BE MADE IN THE STEEL STRUCTURE NOR ANY MATERIAL CUT IN THE FIELD (UNLESS NOTED AS "FIELD CUT OR TRIM" ON DRAWINGS), WITHOUT THE WRITTEN PERMISSION OF THE ENGINEER.
5. NO CUTTING, BURNING, OR HOLES OTHER THAN THOSE SPECIFICALLY DETAILED SHALL BE ALLOWED THROUGH STRUCTURAL STEEL MEMBERS WITHOUT THE PRIOR CONSENT OF THE ENGINEER. BOLT HOLES SHALL CONFORM WITH THE GOVERNING AISC SPECIFICATION, AND SHALL BE STANDARD HOLES UNLESS NOTED OTHERWISE.
6. THE ENGINEER SHALL BE NOTIFIED IMMEDIATELY OF ANY DISCREPANCIES BETWEEN THE DESIGN AND ACTUAL CONDITIONS NOTED IN THE FIELD.
7. CONTRACTOR SHALL PROVIDE NECESSARY LABOR, MATERIAL, AND EQUIPMENT TO ERECT ALL MISCELLANEOUS IRON AND STEEL AS DETAILED ON THESE DRAWINGS.
8. THE CONTRACTOR SHALL FIELD VERIFY ALL DIMENSIONS PRIOR TO FABRICATION.
6. ALL MATERIALS SHALL RECEIVE ONE SHOP COAT OF GRAY STANDARD RUST INHIBITIVE STEEL PRIMER. ALL WELDS, ABRASIONS, AND OTHER SURFACE DEFECTS IN THE SHOP PRIMER SHALL RECEIVE ONE FIELD APPLIED COAT OF RUST INHIBITIVE PRIMER, PRIOR TO ENCLOSURE OR FINAL ACCEPTANCE. PAINT SHALL NOT BE APPLIED TO THOSE MEMBERS WHICH ARE TO BE FIREPROOFED.

MISCELLANEOUS STEEL LINTEL SCHEDULE

SPAN	T	DESCRIPTION	
		WITHOUT FACE BRICK	WITH FACE BRICK
0 TO 6'-0"	8"	(2) L3 1/2 x 3 1/2 x 5/16"	(3) L3 1/2 x 3 1/2 x 5/16" WITH 3/8" x (W-1") PLATE
0 TO 6'-0"	12"	(2) L4 x 4 x 5/16" W/ PL 3/8"x 11"	(3) L4 x 4 x 5/16" WITH 3/8" x (W-1") PLATE
REFERENCE DETAIL		A	B

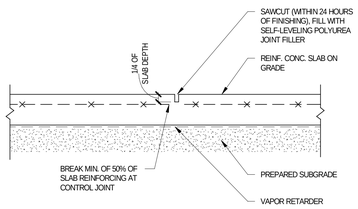
NOTES:

1. LINTEL SIZES SHOWN IN THIS SCHEDULE ARE FOR OPENINGS LESS THAN 6'-0".
2. LINTELS SHALL BEAR A MINIMUM OF 8" ON FULLY GROUTED COURSES OF SOLID MASONRY.
3. ALL LINTELS AT EXTERIOR LOCATIONS OR OTHERWISE SUBJECT TO WEATHER OR CORROSIVE ATMOSPHERE SHALL BE GALVANIZED. LINTELS CONSISTING OF A PLATE AND PAIR OF ANGLES SHALL HAVE BOTH PLATE AND ANGLES GALVANIZED AFTER WELDING. ALL ANGLES SHALL BE GALVANIZED.
4. LINTELS UTILIZING BOTTOM PLATES SHALL HAVE PLATE EXTEND FULL LENGTH OF MASONRY OPENING ONLY. BOTTOM PLATES SHALL NOT EXTEND INTO JAMBS OF WALL OPENINGS.
5. FOR OPENINGS 16 INCHES AND SMALLER, PROVIDE SOLID GROUTED BOND BEAM WITH (2) #5 BARS WITH 8" MIN. BEARING EACH SIDE OF OPENING.
6. LINTEL SIZES SHOWN IN THIS SCHEDULE ARE FOR SINGLE STORY WALLS ONLY. LINTELS SUPPORTING MULTI-STORY WALLS REQUIRE FURTHER ANALYSIS.

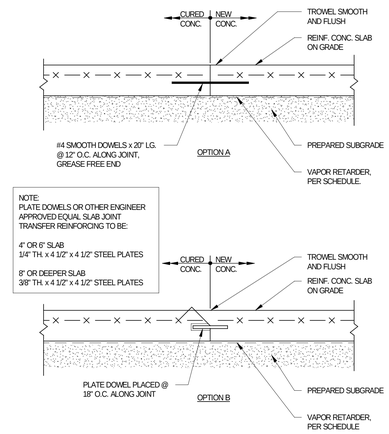


1 MISCELLANEOUS STEEL LINTEL SCHEDULE
NOT TO SCALE

REINF. CONC. FLOOR SLAB	
MARK	DESCRIPTION
SLAB-1	CONC. SLAB TO MATCH EXISTING THICKNESS ON GRADE W 6x6 - W2.9x W2.9 WWF, OVER MINIMUM 6" OF COMPACTED GRANULAR FILL AND 10 MIL VAPOR BARRIER, TYP. U.N.O.



3 SLAB ON GRADE CONTROL JOINT DETAIL
NOT TO SCALE



2 SLAB ON GRADE CONSTRUCTION JOINT DETAIL
NOT TO SCALE

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STRUCTURAL DETAILS

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0117
DATE: 11-NOV-2022
SHEET
A-002

CONSTRUCTION DOCUMENTS

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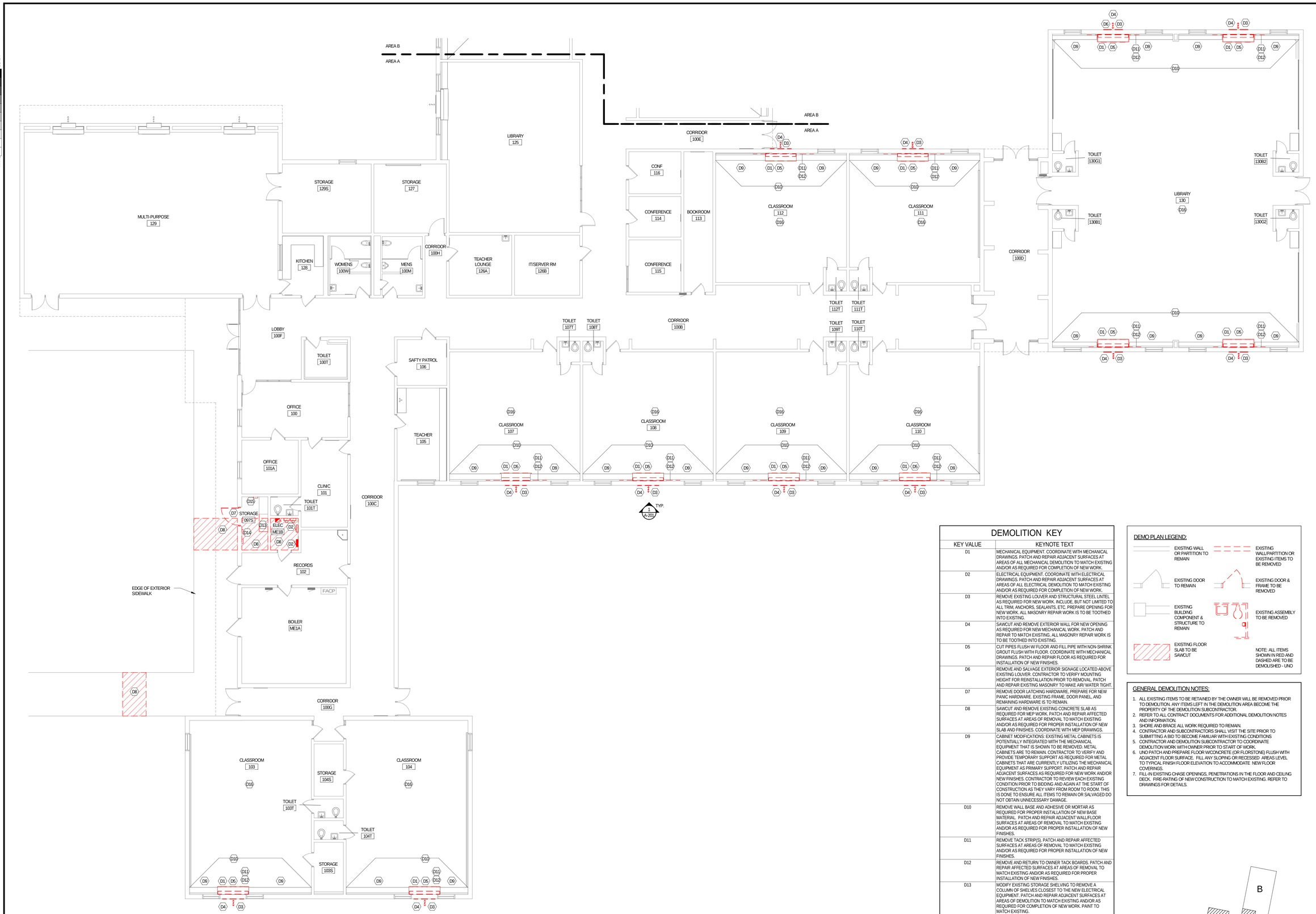
DESIGNED BY: Designer
CHECKED BY: Checker APPROVED BY: Approver

ME RECYCLE
THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK
WHITE



DEMOLITION PLAN - AREA A
1/8" = 1'-0"

DEMOLITION KEY

KEY VALUE	KEYNOTE TEXT
D1	MECHANICAL EQUIPMENT. COORDINATE WITH MECHANICAL DRAWINGS. PATCH AND REPAIR ADJACENT SURFACES AT AREAS OF ALL MECHANICAL DEMOLITION TO MATCH EXISTING AND/OR AS REQUIRED FOR COMPLETION OF NEW WORK.
D2	ELECTRICAL EQUIPMENT. COORDINATE WITH ELECTRICAL DRAWINGS. PATCH AND REPAIR ADJACENT SURFACES AT AREAS OF ALL ELECTRICAL DEMOLITION TO MATCH EXISTING AND/OR AS REQUIRED FOR COMPLETION OF NEW WORK.
D3	REMOVE EXISTING LOUVER AND STRUCTURAL STEEL LINTEL AS REQUIRED FOR NEW WORK. INCLUDE, BUT NOT LIMITED TO ALL TRIM, ANCHORS, SEALANTS, ETC. PREPARE OPENING FOR NEW WORK. ALL MASONRY REPAIR WORK IS TO BE TOOTHED INTO EXISTING.
D4	SAWCUT AND REMOVE EXTERIOR WALL FOR NEW OPENING AS REQUIRED FOR NEW MECHANICAL WORK. PATCH AND REPAIR TO MATCH EXISTING, ALL MASONRY REPAIR WORK IS TO BE TOOTHED INTO EXISTING.
D5	CUT PIPES FLUSH W/ FLOOR AND FILL PIPE WITH NON-SHRINK GROUT FLUSH WITH FLOOR. COORDINATE WITH MECHANICAL DRAWINGS. PATCH AND REPAIR FLOOR AS REQUIRED FOR INSTALLATION OF NEW FINISHES.
D6	REMOVE AND SALVAGE EXTERIOR SIGNAGE LOCATED ABOVE EXISTING LOUVER. CONTRACTOR TO VERIFY MOUNTING HEIGHT FOR REINSTALLATION PRIOR TO REMOVAL. PATCH AND REPAIR EXISTING MASONRY TO MAKE AIR/ WATER TIGHT.
D7	REMOVE DOOR LATCHING HARDWARE, PREPARE FOR NEW PANIC HARDWARE. EXISTING FRAME, DOOR PANEL, AND REMAINING HARDWARE IS TO REMAIN.
D8	SAWCUT AND REMOVE EXISTING CONCRETE SLAB AS REQUIRED FOR MEP WORK. PATCH AND REPAIR AFFECTED SURFACES AT AREAS OF REMOVAL TO MATCH EXISTING AND/OR AS REQUIRED FOR PROPER INSTALLATION OF NEW SLAB AND FINISHES. COORDINATE WITH MEP DRAWINGS.
D9	CABINET MODIFICATIONS: EXISTING METAL CABINETS IS POTENTIALLY INTEGRATED WITH THE MECHANICAL EQUIPMENT THAT IS SHOWN TO BE REMOVED. METAL CABINETS ARE TO REMAIN. CONTRACTOR TO VERIFY AND PROVIDE TEMPORARY SUPPORT AS REQUIRED FOR METAL CABINETS THAT ARE CURRENTLY UTILIZING THE MECHANICAL EQUIPMENT AS PRIMARY SUPPORT. PATCH AND REPAIR ADJACENT SURFACES AS REQUIRED FOR NEW WORK AND/OR NEW FINISHES. CONTRACTOR TO REVIEW EACH EXISTING CONDITION PRIOR TO BIDDING AND AGAIN AT THE START OF CONSTRUCTION AS THEY VARY FROM ROOM TO ROOM. THIS IS DONE TO ENSURE ALL ITEMS TO REMAIN OR SALVAGED DO NOT OBTAIN UNNECESSARY DAMAGE.
D10	REMOVE WALL BASE AND ADHESIVE OR MORTAR AS REQUIRED FOR PROPER INSTALLATION OF NEW BASE MATERIAL. PATCH AND REPAIR ADJACENT WALL/FLOOR SURFACES AT AREAS OF REMOVAL TO MATCH EXISTING AND/OR AS REQUIRED FOR PROPER INSTALLATION OF NEW FINISHES.
D11	REMOVE TACK STRIP(S). PATCH AND REPAIR AFFECTED SURFACES AT AREAS OF REMOVAL TO MATCH EXISTING AND/OR AS REQUIRED FOR PROPER INSTALLATION OF NEW FINISHES.
D12	REMOVE AND RETURN TO OWNER TACK BOARDS. PATCH AND REPAIR AFFECTED SURFACES AT AREAS OF REMOVAL TO MATCH EXISTING AND/OR AS REQUIRED FOR PROPER INSTALLATION OF NEW FINISHES.
D13	MODIFY EXISTING STORAGE SHELVING TO REMOVE A COLUMN OF SHELVES CLOSEST TO THE NEW ELECTRICAL EQUIPMENT. PATCH AND REPAIR ADJACENT SURFACES AT AREAS OF DEMOLITION TO MATCH EXISTING AND/OR AS REQUIRED FOR COMPLETION OF NEW WORK. PAINT TO MATCH EXISTING.
D14	REMOVE AND SALVAGE EXISTING WALL MOUNTED PEG HOOKS. PATCH AND REPAIR WALL SURFACES AS REQUIRED TO MAKE LIKE NEW. PAINT ANY DAMAGE TO MATCH EXISTING. CONTRACTOR TO DOCUMENT MOUNTING HEIGHT PRIOR TO REMOVAL.
D15	REMOVE AND RETURN TO OWNER EXISTING WALL MOUNTED PEG HOOKS. PATCH AND REPAIR WALL SURFACES AS REQUIRED TO MAKE LIKE NEW. PAINT ANY DAMAGE TO MATCH EXISTING.
D16	REMOVE, SALVAGE, AND REINSTALL EXISTING SUSPENDED CEILING SYSTEM AS REQUIRED FOR NEW MECHANICAL WORK. COORDINATE WITH MECHANICAL AND ELECTRICAL DRAWINGS.

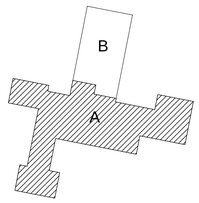
DEMO PLAN LEGEND:

- EXISTING WALL OR PARTITION TO REMAIN
- EXISTING WALL/PARTITION OR EXISTING ITEMS TO BE REMOVED
- EXISTING DOOR TO REMAIN
- EXISTING DOOR & FRAME TO BE REMOVED
- EXISTING BUILDING COMPONENT & STRUCTURE TO REMAIN
- EXISTING ASSEMBLY TO BE REMOVED
- EXISTING FLOOR SLAB TO BE SAWCUT

NOTE: ALL ITEMS SHOWN IN RED AND DASHED ARE TO BE DEMOLISHED - UNO

GENERAL DEMOLITION NOTES:

1. ALL EXISTING ITEMS TO BE RETAINED BY THE OWNER WILL BE REMOVED PRIOR TO DEMOLITION. ANY ITEMS LEFT IN THE DEMOLITION AREA BECOME THE PROPERTY OF THE DEMOLITION SUBCONTRACTOR.
2. REFER TO ALL CONTRACT DOCUMENTS FOR ADDITIONAL DEMOLITION NOTES AND INFORMATION.
3. SHORE AND BRACE ALL WORK REQUIRED TO REMAIN.
4. CONTRACTOR AND SUBCONTRACTORS SHALL VISIT THE SITE PRIOR TO SUBMITTING A BID TO BECOME FAMILIAR WITH EXISTING CONDITIONS
5. CONTRACTOR AND DEMOLITION SUBCONTRACTOR TO COORDINATE DEMOLITION WORK WITH OWNER PRIOR TO START OF WORK.
6. UNO PATCH AND PREPARE FLOOR W/CONCRETE (OR FLORSTONE) FLUSH WITH ADJACENT FLOOR SURFACE. FILL ANY SLOPING OR RECESSED AREAS LEVEL TO TYPICAL FINISH FLOOR ELEVATION TO ACCOMMODATE NEW FLOOR COVERINGS.
7. FILL-IN EXISTING CHASE OPENINGS, PENETRATIONS IN THE FLOOR AND CEILING DECK. FIRE-RATING OF NEW CONSTRUCTION TO MATCH EXISTING. REFER TO DRAWINGS FOR DETAILS.



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DEMOLITION PLAN - AREA A

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0117

DATE: 11-NOV-2022

SHEET

AD101A

CONSTRUCTION DOCUMENTS

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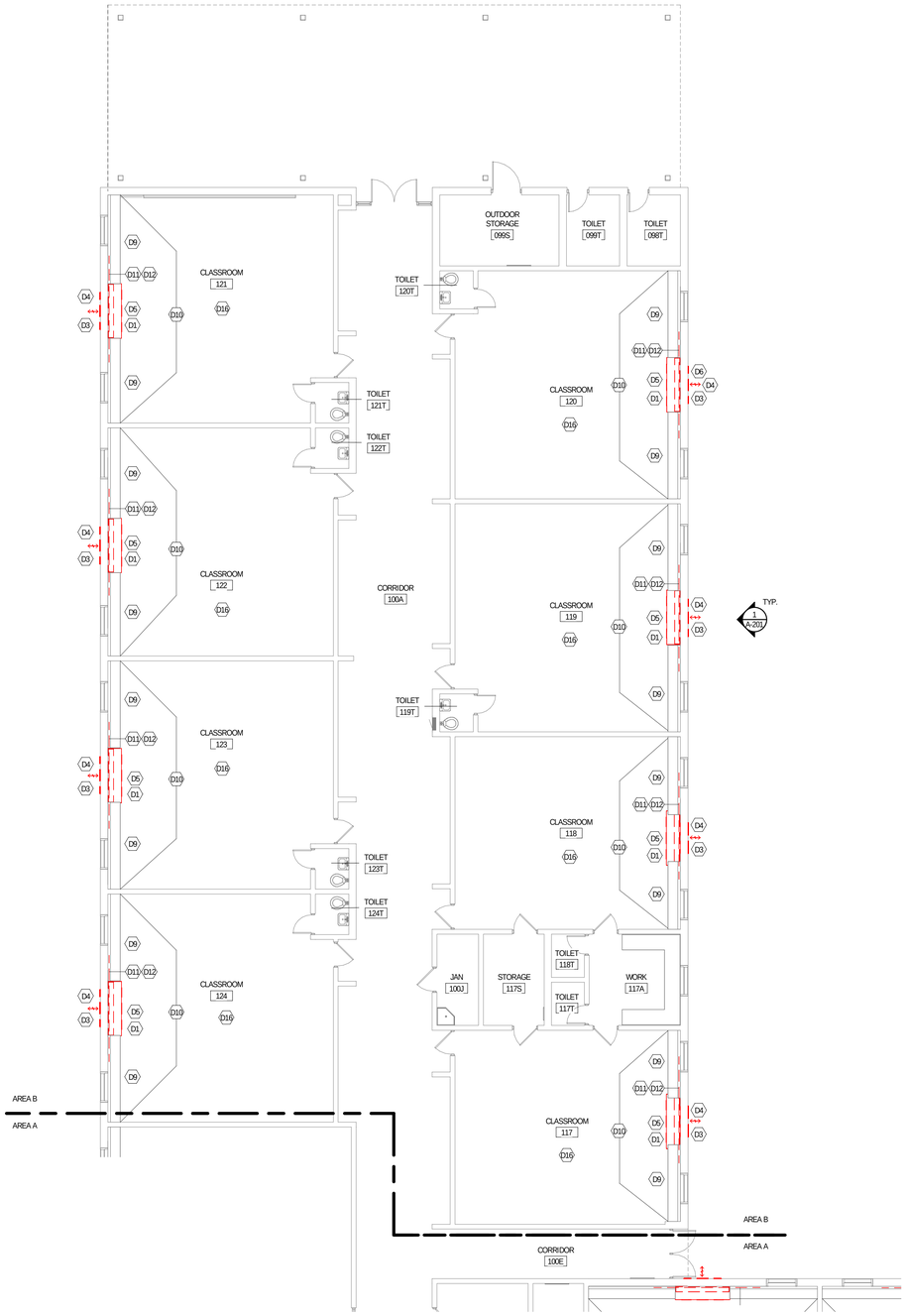
DESIGNED BY: Designer
CHECKED BY: Checker APPROVED BY: Approver

THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK
WHITE
ME RECYCLE



DEMOLITION PLAN - AREA B
1/8" = 1'-0"

DEMO PLAN LEGEND:

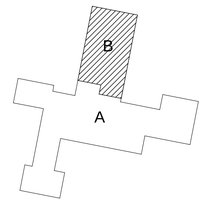
- EXISTING WALL OR PARTITION TO REMAIN
- EXISTING WALL/PARTITION OR EXISTING ITEMS TO BE REMOVED
- EXISTING DOOR TO REMAIN
- EXISTING DOOR & FRAME TO BE REMOVED
- EXISTING BUILDING COMPONENT & STRUCTURE TO REMAIN
- EXISTING ASSEMBLY TO BE REMOVED
- EXISTING FLOOR SLAB TO BE SAWCUT
- NOTE: ALL ITEMS SHOWN IN RED AND DASHED ARE TO BE DEMOLISHED - UNO

GENERAL DEMOLITION NOTES:

1. ALL EXISTING ITEMS TO BE RETAINED BY THE OWNER WILL BE REMOVED PRIOR TO DEMOLITION. ANY ITEMS LEFT IN THE DEMOLITION AREA BECOME THE PROPERTY OF THE DEMOLITION SUBCONTRACTOR.
2. REFER TO ALL CONTRACT DOCUMENTS FOR ADDITIONAL DEMOLITION NOTES AND INFORMATION.
3. SHORE AND BRACE ALL WORK REQUIRED TO REMAIN.
4. CONTRACTOR AND SUBCONTRACTORS SHALL VISIT THE SITE PRIOR TO SUBMITTING A BID TO BECOME FAMILIAR WITH EXISTING CONDITIONS
5. CONTRACTOR AND DEMOLITION SUBCONTRACTOR TO COORDINATE DEMOLITION WORK WITH OWNER PRIOR TO START OF WORK.
6. UNO PATCH AND PREPARE FLOOR W/CONCRETE (OR FLORSTONE) FLUSH WITH ADJACENT FLOOR SURFACE. FILL ANY SLOPING OR RECESSED AREAS LEVEL TO TYPICAL FINISH FLOOR ELEVATION TO ACCOMMODATE NEW FLOOR COVERINGS.
7. FILL-IN EXISTING CHASE OPENINGS, PENETRATIONS IN THE FLOOR AND CEILING DECK. FIRE-RATING OF NEW CONSTRUCTION TO MATCH EXISTING. REFER TO DRAWINGS FOR DETAILS.

DEMOLITION KEY

KEY VALUE	KEYNOTE TEXT
D1	MECHANICAL EQUIPMENT. COORDINATE WITH MECHANICAL DRAWINGS. PATCH AND REPAIR ADJACENT SURFACES AT AREAS OF ALL MECHANICAL DEMOLITION TO MATCH EXISTING AND/OR AS REQUIRED FOR COMPLETION OF NEW WORK.
D3	REMOVE EXISTING LOUVER AND STRUCTURAL STEEL LINTEL AS REQUIRED FOR NEW WORK. INCLUDE, BUT NOT LIMITED TO ALL TRIM, ANCHORS, SEALANTS, ETC. PREPARE OPENING FOR NEW WORK. ALL MASONRY REPAIR WORK IS TO BE TOOTHED INTO EXISTING.
D4	SAWCUT AND REMOVE EXTERIOR WALL FOR NEW OPENING AS REQUIRED FOR NEW MECHANICAL WORK. PATCH AND REPAIR TO MATCH EXISTING. ALL MASONRY REPAIR WORK IS TO BE TOOTHED INTO EXISTING.
D5	CUT PIPES FLUSH W/ FLOOR AND FILL PIPE WITH NON-SHRINK GROUT FLUSH WITH FLOOR. COORDINATE WITH MECHANICAL DRAWINGS. PATCH AND REPAIR FLOOR AS REQUIRED FOR INSTALLATION OF NEW FINISHES.
D6	REMOVE AND SALVAGE EXTERIOR SIGNAGE LOCATED ABOVE EXISTING LOUVER. CONTRACTOR TO VERIFY MOUNTING HEIGHT FOR REINSTALLATION PRIOR TO REMOVAL. PATCH AND REPAIR EXISTING MASONRY TO MAKE AIR/ WATER TIGHT.
D9	CABINET MODIFICATIONS: EXISTING METAL CABINETS IS POTENTIALLY INTEGRATED WITH THE MECHANICAL EQUIPMENT THAT IS SHOWN TO BE REMOVED. METAL CABINETS ARE TO REMAIN. CONTRACTOR TO VERIFY AND PROVIDE TEMPORARY SUPPORT AS REQUIRED FOR METAL CABINETS THAT ARE CURRENTLY UTILIZING THE MECHANICAL EQUIPMENT AS PRIMARY SUPPORT. PATCH AND REPAIR ADJACENT SURFACES AS REQUIRED FOR NEW WORK AND/OR NEW FINISHES. CONTRACTOR TO REVIEW EACH EXISTING CONDITION PRIOR TO BIDDING AND AGAIN AT THE START OF CONSTRUCTION AS THEY VARY FROM ROOM TO ROOM. THIS IS DONE TO ENSURE ALL ITEMS TO REMAIN OR SALVAGED DO NOT OBTAIN UNNECESSARY DAMAGE.
D10	REMOVE WALL BASE AND ADHESIVE OR MORTAR AS REQUIRED FOR PROPER INSTALLATION OF NEW BASE MATERIAL. PATCH AND REPAIR ADJACENT WALL/FLOOR SURFACES AT AREAS OF REMOVAL TO MATCH EXISTING AND/OR AS REQUIRED FOR PROPER INSTALLATION OF NEW FINISHES.
D11	REMOVE TACK STRIP(S). PATCH AND REPAIR AFFECTED SURFACES AT AREAS OF REMOVAL TO MATCH EXISTING AND/OR AS REQUIRED FOR PROPER INSTALLATION OF NEW FINISHES.
D12	REMOVE AND RETURN TO OWNER TACK BOARDS. PATCH AND REPAIR AFFECTED SURFACES AT AREAS OF REMOVAL TO MATCH EXISTING AND/OR AS REQUIRED FOR PROPER INSTALLATION OF NEW FINISHES.
D16	REMOVE, SALVAGE, AND REINSTALL EXISTING SUSPENDED CEILING SYSTEM AS REQUIRED FOR NEW MECHANICAL WORK. COORDINATE WITH MECHANICAL AND ELECTRICAL DRAWINGS.



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DEMOLITION PLAN - AREA B

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0117
DATE: 11-NOV-2022
SHEET
AD101B

CONSTRUCTION DOCUMENTS

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DESIGNED BY: Designer
CHECKED BY: Checker APPROVED BY: Approver

THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK

WE RECYCLE

WHITE

MULTI-PURPOSE 129

STORAGE 129S

STORAGE 127

LIBRARY 125

KITCHEN 128

WOMENS 100W

MENS 100M

CORRIDOR 100H

TEACHER LOUNGE 126A

IT/SERVER RM 126B

CORRIDOR 100E

CONF 116

CONFERENCE 114

CONFERENCE 115

BOOKROOM 113

CLASSROOM 112

CLASSROOM 111

TOILET 112T

TOILET 111T

CORRIDOR 100B

TOILET 107T

TOILET 108T

TOILET 109T

TOILET 110T

LOBBY 100F

TOILET 100T

OFFICE 100

OFFICE 101A

CLINC 101

TOILET 101T

SAFTY PATROL 106

TEACHER 105

CLASSROOM 107

CLASSROOM 108

CLASSROOM 109

CLASSROOM 110

CORRIDOR 100C

097S.1

CONCRETE SIDEWALK TO MATCH EXISTING

ELEC ME1B

STORAGE 097S

RECORDS 102

EDGE OF EXTERIOR SIDEWALK

FACP

BOILER ME1A

CONCRETE SIDEWALK TO MATCH EXISTING

CONCRETE PAD, SEE ELECTRICAL

CORRIDOR 100G

CLASSROOM 103

STORAGE 104S

CLASSROOM 104

TOILET 103T

TOILET 104T

STORAGE 103S

15'-1/4"

4'-1/4"

2 A-201

4 A-201

TOILET 130G1

TOILET 130B2

LIBRARY 130

TOILET 130B1

TOILET 130G2

CORRIDOR 100D

FLOOR PLAN KEY

KEY VALUE	KEYNOTE TEXT
A1	PROVIDE NEW LOUVER AND STEEL LINTEL AS REQUIRED FOR NEW MECHANICAL EQUIPMENT. REFER TO THE MISCELLANEOUS STEEL LINTEL SCHEDULE FOR INFORMATION ON THE NEW STEEL LINTEL. COORDINATE LOUVER SIZE WITH MECHANICAL DRAWINGS. FINAL PLACEMENT OF LOUVER IS DETERMINED BY MECHANICAL EQUIPMENT. PATCH AND REPAIR ALL ADJACENT WALL INFILL TO MATCH EXISTING. ALL MASONRY REPAIR WORK IS TO BE TOOTHED INTO EXISTING.
A2	INFILL EXISTING WALL OPENING WITH NEW MATERIALS TO MATCH EXISTING. STEEL LINTELS TO REMAIN. ALL MASONRY REPAIR WORK IS TO BE TOOTHED INTO EXISTING. PATCH AND REPAIR ALL SURFACES AS REQUIRED FOR PROPER INSTALLATION OF NEW FINISHES.
A3	CABINET MODIFICATIONS: REPLACE ANY TEMPORARY CABINET SUPPORT WITH A FINISHED END PANEL THAT PROVIDES THE ABILITY TO MEET OR EXCEED THE EXISTING SUPPORT. ALL EXPOSED EXISTING TRIM SHALL BE GRINDED SMOOTH TO ENSURE NO SHARP EDGES. CONTRACTOR TO REVIEW EACH EXISTING CONDITION PRIOR TO BIDDING AND AGAIN AT THE START OF CONSTRUCTION AS THEY VARY FROM ROOM TO ROOM.
A4	MECHANICAL EQUIPMENT. COORDINATE WITH MECHANICAL DRAWINGS.
A5	ELECTRICAL EQUIPMENT. COORDINATE WITH ELECTRICAL DRAWINGS.
A7	PROVIDE NEW CONCRETE FLOOR SLAB PER STRUCTURAL DETAILS.
A8	NEW WALL BASE TO MATCH EXISTING.
A10	NEW METAL FILLER PANEL AND TOP TO MATCH ADJACENT CASEWORK PROFILE AND OVERALL HEIGHT. FILLER PANEL COLOR IS TO MATCH ADJACENT MECHANICAL EQUIPMENT. REINFORCE FILLER PANEL TO ENSURE OIL CANNING WILL NOT OCCUR AND IS NOT EASILY DAMAGED. PROVIDE ISOLATION MATERIAL WHERE METAL FILLER PANEL AND TOP MEET NEW MECHANICAL UNIT AND EXISTING CASEWORK AND COUNTERTOP TO REMAIN. CONTRACTOR TO REVIEW EACH EXISTING CONDITION PRIOR TO BIDDING AND AGAIN AT THE START OF CONSTRUCTION AS THEY VARY FROM ROOM TO ROOM AND EACH LOCATION WILL BE CUSTOM IN OVERALL DIMENSIONS.
A11	NEW PLASTIC LAMINATE BASE CABINET WITH (1) ADJUSTABLE SHELF. OVERALL WIDTH OF BASE CABINET VARIES, WIDTH IS TO MATCH VACANT SPACE BETWEEN NEW MECHANICAL EQUIPMENT AND EXISTING BASE CABINET. PROFILE AND ALL OTHER DIMENSIONS IS TO MATCH ADJACENT CASEWORK TO ENSURE SEAMLESS FINISH MATERIAL TRANSITIONS. PROVIDE ISOLATION MATERIAL WHERE BASE CABINET MEETS THE NEW MECHANICAL UNIT AND EXISTING CASEWORK TO REMAIN. CONTRACTOR TO REVIEW EACH EXISTING CONDITION PRIOR TO BIDDING AND AGAIN AT THE START OF CONSTRUCTION AS THEY VARY FROM ROOM TO ROOM AND EACH LOCATION WILL BE CUSTOM IN OVERALL DIMENSIONS. PLAM MATERIAL IS TO BE: ARBORITE, NEW SAND, S444.
A12	REINSTALL EXTERIOR SIGNAGE AT MOUNTING HEIGHT TO MATCH EXISTING. PLACE ADJACENT TO NEW LOUVER.
A13	EXISTING FLOORING IS TO REMAIN AND IS EITHER VCT OR CARPET, COLORS VARY. CONTRACTOR TO ENSURE FLOORING SURROUNDING THE NEW MECHANICAL UNIT/ BASE CABINETS' FILLER PANELS MATCH UP TO NEW WORK. ANY PATCH AND REPAIR WORK REQUIRED FOR FLOORS DUE TO NEW WORK ARE TO MATCH EXISTING.
A14	MODIFY EXISTING STORAGE SHELVING TO REMOVE A COLUMN OF SHELVES CLOSEST TO THE NEW ELECTRICAL EQUIPMENT. PAINT WALLS AS REQUIRED TO MATCH EXISTING AT AREAS OF REMOVAL.
A15	INSTALL SALVAGED WALL MOUNTED PEG HOOKS AT THE SAME HEIGHT PRIOR TO REMOVAL. PATCH AND REPAIR WALL SURFACES AS REQUIRED TO MAKE LIKE NEW. PAINT AREA OF WORK TO MATCH EXISTING.

GENERAL NOTES:

1. SUB-CONTRACTORS ARE TO COORDINATE WORK WITH ALL OTHER TRADES.
2. CONFLICTS BETWEEN NOTES, DETAILS, SPECIFICATIONS, ETC., SHALL BE VERIFIED WITH THE OWNER'S REPRESENTATIVE OR THE MOST STRINGENT PROVISIONS SHALL GOVERN.
3. DETAILS OF CONSTRUCTION NOT FULLY SHOWN SHALL BE OF THE SAME NATURE AS SHOWN FOR SIMILAR CONDITIONS. ANY UNCLEAR CONDITIONS SHALL BE VERIFIED WITH OWNER'S REPRESENTATIVE PRIOR TO CONSTRUCTION OF THAT AREA.
4. DRAWINGS ARE NOT TO BE SCALED. ANY UNCLEAR DIMENSIONS OR DIMENSIONAL DISCREPANCIES SHALL BE VERIFIED WITH OWNER'S REPRESENTATIVE.
5. ALL EXISTING CONDITIONS AND ALL RELATED DIMENSIONS INDICATED IN THE CONTRACT DOCUMENTS SHALL BE FIELD VERIFIED PRIOR TO FABRICATION, ERECTION, AND/OR CONSTRUCTION. ANY CONDITIONS THAT DIFFER FROM THAT INDICATED IN THE CONTRACT DOCUMENTS SHALL BE SUBMITTED TO THE OWNER'S REPRESENTATIVE FOR REVIEW PRIOR TO FABRICATION, ERECTION, AND/OR CONSTRUCTION.
6. CONSTRUCTION MANAGER (CM) / GENERAL CONTRACTOR (GC) TO REVIEW ENTIRE SET OF CONSTRUCTION DOCUMENTS AND SHALL COORDINATE WORK BETWEEN ALL TRADES. IF CONFLICTS ARISE DUE TO COORDINATION OF TRADES, CM / GC IS TO VERIFY CONFLICT WITH OWNER'S REPRESENTATIVE PRIOR TO CONSTRUCTION / INSTALLATION OF CONFLICTING ITEMS.
7. PATCH ALL EXPOSED INTERIOR AND EXTERIOR WALLS WHERE ATTACHED OR IMBEDDED ITEMS WERE REMOVED.
8. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PREPARATIONS OF THE FLOORS, WALLS, AND CEILINGS FOR NEW FINISHES.
9. MAINTAIN FIRE RATING AT ALL ASSEMBLIES WHERE OPENINGS PENETRATIONS, EMBEDMENT, RECESSED EQUIPMENT, ACCESSORIES, ETC. DISRUPT THE CONTINUITY OF THE RATING
10. REMOVE ADHESIVE/OR MORTAR LEFT FROM THE REMOVAL OF EXISTING FLOOR COVERING AND PREP FLOOR W/CONCRETE (OR FLORSTONE) AS NECESSARY TO ACCOMMODATE NEW FLOOR COVERINGS.
11. ALL DIMENSIONS ARE FROM FACE OF STUD, C.M.U., OR CONCRETE , U.N.O.
12. PROVIDE ISOLATION MATERIAL BETWEEN DISSIMILAR MATERIALS THAT ARE IN CONTACT WITH ONE ANOTHER
13. PATCH & REPAIR ALL MAJOR & MINOR BLEMISHES AS REQ'D. DUE TO DEMOLITION WORK. MATCH ADJACENT MATERIAL & COLOR.
14. PROVIDE SOLID, CONTINUOUS, NON COMBUSTIBLE BLOCKING AT LOCATIONS WHERE MILLWORK, PLUMBING FIXTURES, EQUIP., ETC. ATTACH TO WALL OR CEILING.
15. PROVIDE TOUCH-UP PAINT TO MATCH EXISTING WHERE REQUIRED FOR NEW WORK.

FLOOR PLAN - AREA A
1/8" = 1'-0"

B

A

N

KEY PLAN
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FLOOR PLAN - AREA A

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0117

DATE: 11-NOV-2022

SHEET

A-101A

CONSTRUCTION DOCUMENTS

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DESIGNED BY: Designer
CHECKED BY: Checker APPROVED BY: Approver

WE RECYCLE
THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK
WHITE

DOOR AND FRAME SCHEDULE

DOOR			DOOR			FRAME			
			SIZE						
DOOR NO.	ROOM NO.	ROOM NAME	WD.	HGT	TYPE	TYPE	FIRE RATING	HARDWARE SET NO.	NOTES
01.0 LEVEL 1									
097S.1	097S	STORAGE	4' - 0"	7' - 0"	EXIST	EXIST		01	EXISTING DOOR AND FRAME TO REMAIN, NEW PARTIAL HARDWARE ONLY

DOOR & FRAME GENERAL NOTES

1. REFER TO SPECIFICATIONS FOR HARDWARE SETS.
2. EXIST= EXISTING
3. VERIFY EXISTING DOORS AND FRAMES SCHEDULED FOR USE IN RATED WALLS ARE RATED FOR SUCH USE. PROVIDE NEW WHERE REQUIRED.
4. ALL SIDELIGHTS AND TRANSOMS IN 20 MINUTE CORRIDOR DOORS MUST HAVE 3/4 HOUR RATING.

GENERAL NOTES:

1. SUB-CONTRACTORS ARE TO COORDINATE WORK WITH ALL OTHER TRADES.
2. CONFLICTS BETWEEN NOTES, DETAILS, SPECIFICATIONS, ETC., SHALL BE VERIFIED WITH THE OWNER'S REPRESENTATIVE OR THE MOST STRINGENT PROVISIONS SHALL GOVERN.
3. DETAILS OF CONSTRUCTION NOT FULLY SHOWN SHALL BE OF THE SAME NATURE AS SHOWN FOR SIMILAR CONDITIONS. ANY UNCLEAR CONDITIONS SHALL BE VERIFIED WITH OWNER'S REPRESENTATIVE PRIOR TO CONSTRUCTION OF THAT AREA.
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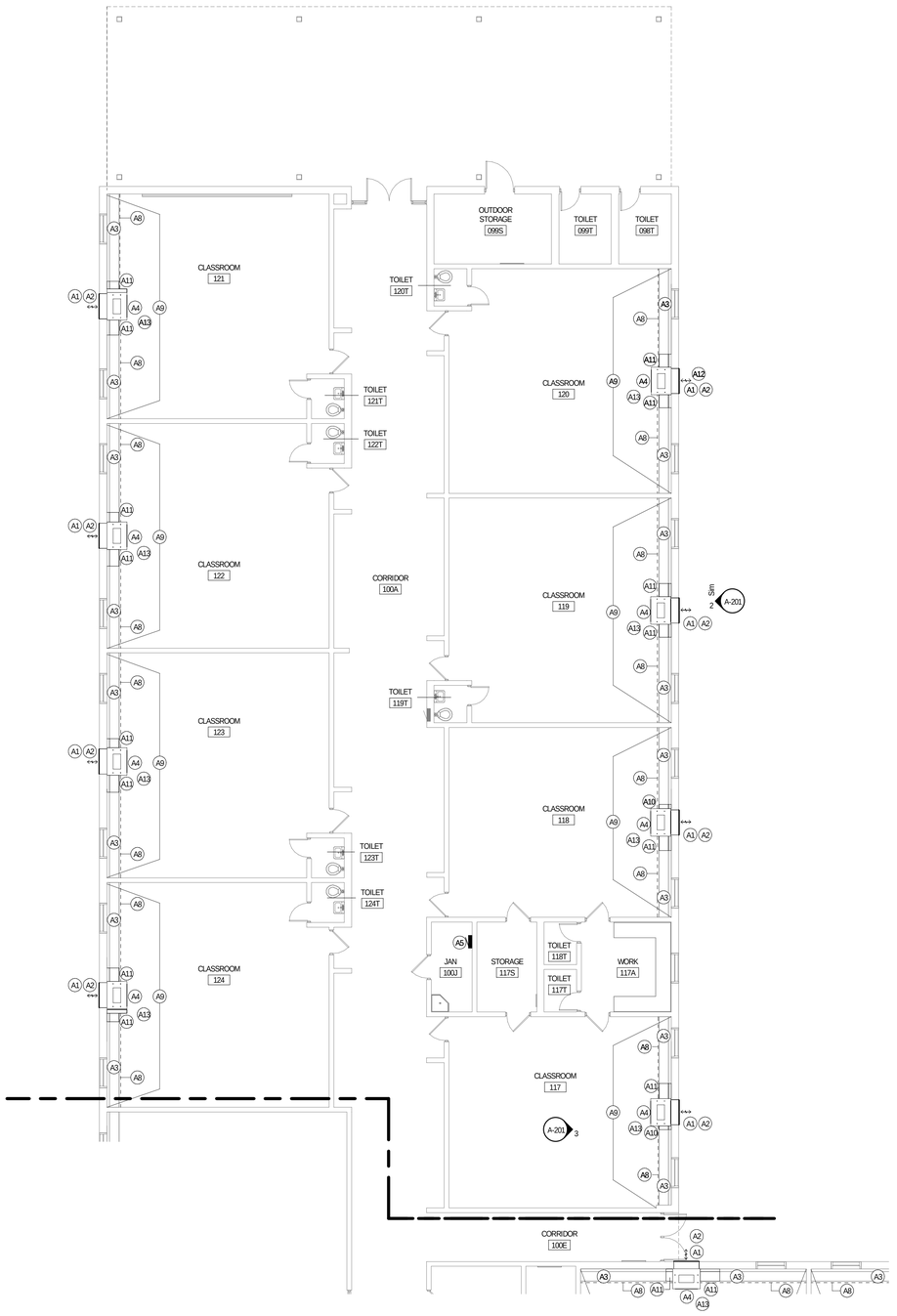
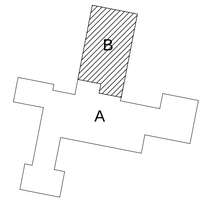
5. ALL EXISTING CONDITIONS AND ALL RELATED DIMENSIONS INDICATED IN THE CONTRACT DOCUMENTS SHALL BE FIELD VERIFIED PRIOR TO FABRICATION, ERECTION, AND/OR CONSTRUCTION. ANY CONDITIONS THAT DIFFER FROM THAT INDICATED IN THE CONTRACT DOCUMENTS SHALL BE SUBMITTED TO THE OWNER'S REPRESENTATIVE FOR REVIEW PRIOR TO FABRICATION, ERECTION, AND/OR CONSTRUCTION.
6. CONSTRUCTION MANAGER (CM) / GENERAL CONTRACTOR (GC) TO REVIEW ENTIRE SET OF CONSTRUCTION DOCUMENTS AND SHALL COORDINATE WORK BETWEEN ALL TRADES. IF CONFLICTS ARISE DUE TO COORDINATION OF TRADES, CM / GC IS TO VERIFY CONFLICT WITH OWNER'S REPRESENTATIVE PRIOR TO CONSTRUCTION / INSTALLATION OF CONFLICTING ITEMS.
7. PATCH ALL EXPOSED INTERIOR AND EXTERIOR WALLS WHERE ATTACHED OR IMBEDDED ITEMS WERE REMOVED.
8. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PREPARATIONS OF THE FLOORS, WALLS, AND CEILINGS FOR NEW FINISHES.
9. MAINTAIN FIRE RATING AT ALL ASSEMBLIES WHERE OPENINGS PENETRATIONS, EMBEDMENT, RECESSED EQUIPMENT, ACCESSORIES, ETC. DISRUPT THE CONTINUITY OF THE RATING
10. REMOVE ADHESIVE/OR MORTAR LEFT FROM THE REMOVAL OF EXISTING FLOOR COVERING AND PREP FLOOR W/CONCRETE (OR FLORSTONE) AS NECESSARY TO ACCOMMODATE NEW FLOOR COVERINGS.
11. ALL DIMENSIONS ARE FROM FACE OF STUD, C.M.U., OR CONCRETE , U.N.O.
12. PROVIDE ISOLATION MATERIAL BETWEEN DISSIMILAR MATERIALS THAT ARE IN CONTACT WITH ONE ANOTHER.
13. PATCH & REPAIR ALL MAJOR & MINOR BLEMISHES AS REQ'D. DUE TO DEMOLITION WORK. MATCH ADJACENT MATERIAL & COLOR.
14. PROVIDE SOLID, CONTINUOUS, NON COMBUSTIBLE BLOCKING AT LOCATIONS WHERE MILLWORK, PLUMBING FIXTURES, EQUIP., ETC. ATTACH TO WALL OR CEILING.
15. PROVIDE TOUCH-UP PAINT TO MATCH EXISTING WHERE REQUIRED FOR NEW WORK.



FLOOR PLAN - AREA B
1/8" = 1'-0"

FLOOR PLAN KEY

KEY VALUE	KEYNOTE TEXT
A1	PROVIDE NEW LOUVER AND STEEL LINTEL AS REQUIRED FOR NEW MECHANICAL EQUIPMENT. REFER TO THE MISCELLANEOUS STEEL LINTEL SCHEDULE FOR INFORMATION ON THE NEW STEEL LINTEL. COORDINATE LOUVER SIZE WITH MECHANICAL DRAWINGS. FINAL PLACEMENT OF LOUVER IS DETERMINED BY MECHANICAL EQUIPMENT. PATCH AND REPAIR ALL ADJACENT WALL INFILL TO MATCH EXISTING. ALL MASONRY REPAIR WORK IS TO BE TOOTHED INTO EXISTING.
A2	INFILL EXISTING WALL OPENING WITH NEW MATERIALS TO MATCH EXISTING. STEEL LINTELS TO REMAIN. ALL MASONRY REPAIR WORK IS TO BE TOOTHED INTO EXISTING. PATCH AND REPAIR ALL SURFACES AS REQUIRED FOR PROPER INSTALLATION OF NEW FINISHES.
A3	CABINET MODIFICATIONS: REPLACE ANY TEMPORARY CABINET SUPPORT WITH A FINISHED END PANEL THAT PROVIDES THE ABILITY TO MEET OR EXCEED THE EXISTING SUPPORT. ALL EXPOSED EXISTING TRIM SHALL BE GRINDED SMOOTH TO ENSURE NO SHARP EDGES. CONTRACTOR TO REVIEW EACH EXISTING CONDITION PRIOR TO BIDDING AND AGAIN AT THE START OF CONSTRUCTION AS THEY VARY FROM ROOM TO ROOM.
A4	MECHANICAL EQUIPMENT. COORDINATE WITH MECHANICAL DRAWINGS.
A5	ELECTRICAL EQUIPMENT. COORDINATE WITH ELECTRICAL DRAWINGS.
A8	NEW WALL BASE TO MATCH EXISTING.
A9	PAINT WALLS TO MATCH EXISTING.
A10	NEW METAL FILLER PANEL AND TOP TO MATCH ADJACENT CASEWORK PROFILE AND OVERALL HEIGHT. FILLER PANEL COLOR IS TO MATCH ADJACENT MECHANICAL EQUIPMENT. REINFORCE FILLER PANEL TO ENSURE OIL CANNING WILL NOT OCCUR AND IS NOT EASILY DAMAGED. PROVIDE ISOLATION MATERIAL WHERE METAL FILLER PANEL AND TOP MEET NEW MECHANICAL UNIT AND EXISTING CASEWORK AND COUNTERTOP TO REMAIN. CONTRACTOR TO REVIEW EACH EXISTING CONDITION PRIOR TO BIDDING AND AGAIN AT THE START OF CONSTRUCTION AS THEY VARY FROM ROOM TO ROOM AND EACH LOCATION WILL BE CUSTOM IN OVERALL DIMENSIONS.
A11	NEW PLASTIC LAMINATE BASE CABINET WITH (1) ADJUSTABLE SHELF. OVERALL WIDTH OF BASE CABINET VARIES. WIDTH IS TO MATCH VACANT SPACE BETWEEN NEW MECHANICAL EQUIPMENT AND EXISTING BASE CABINET. PROFILE AND ALL OTHER DIMENSIONS IS TO MATCH ADJACENT CASEWORK TO ENSURE SEAMLESS FINISH MATERIAL TRANSITIONS. PROVIDE ISOLATION MATERIAL WHERE BASE CABINET MEETS THE NEW MECHANICAL UNIT AND EXISTING CASEWORK TO REMAIN. CONTRACTOR TO REVIEW EACH EXISTING CONDITION PRIOR TO BIDDING AND AGAIN AT THE START OF CONSTRUCTION AS THEY VARY FROM ROOM TO ROOM AND EACH LOCATION WILL BE CUSTOM IN OVERALL DIMENSIONS. PLAM MATERIAL IS TO BE: ARBORITE, NEW SAND, S444.
A12	REINSTALL EXTERIOR SIGNAGE AT MOUNTING HEIGHT TO MATCH EXISTING. PLACE ADJACENT TO NEW LOUVER.
A13	EXISTING FLOORING IS TO REMAIN AND IS EITHER VCT OR CARPET, COLORS VARY. CONTRACTOR TO ENSURE FLOORING SURROUNDING THE NEW MECHANICAL UNIT/ BASE CABINETS/ FILLER PANELS MATCH UP TO NEW WORK. ANY PATCH AND REPAIR WORK REQUIRED FOR FLOORS DUE TO NEW WORK ARE TO MATCH EXISTING.



KEY PLAN
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FLOOR PLAN - AREA B

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0117
DATE: 11-NOV-2022
SHEET
A-101B

CONSTRUCTION DOCUMENTS

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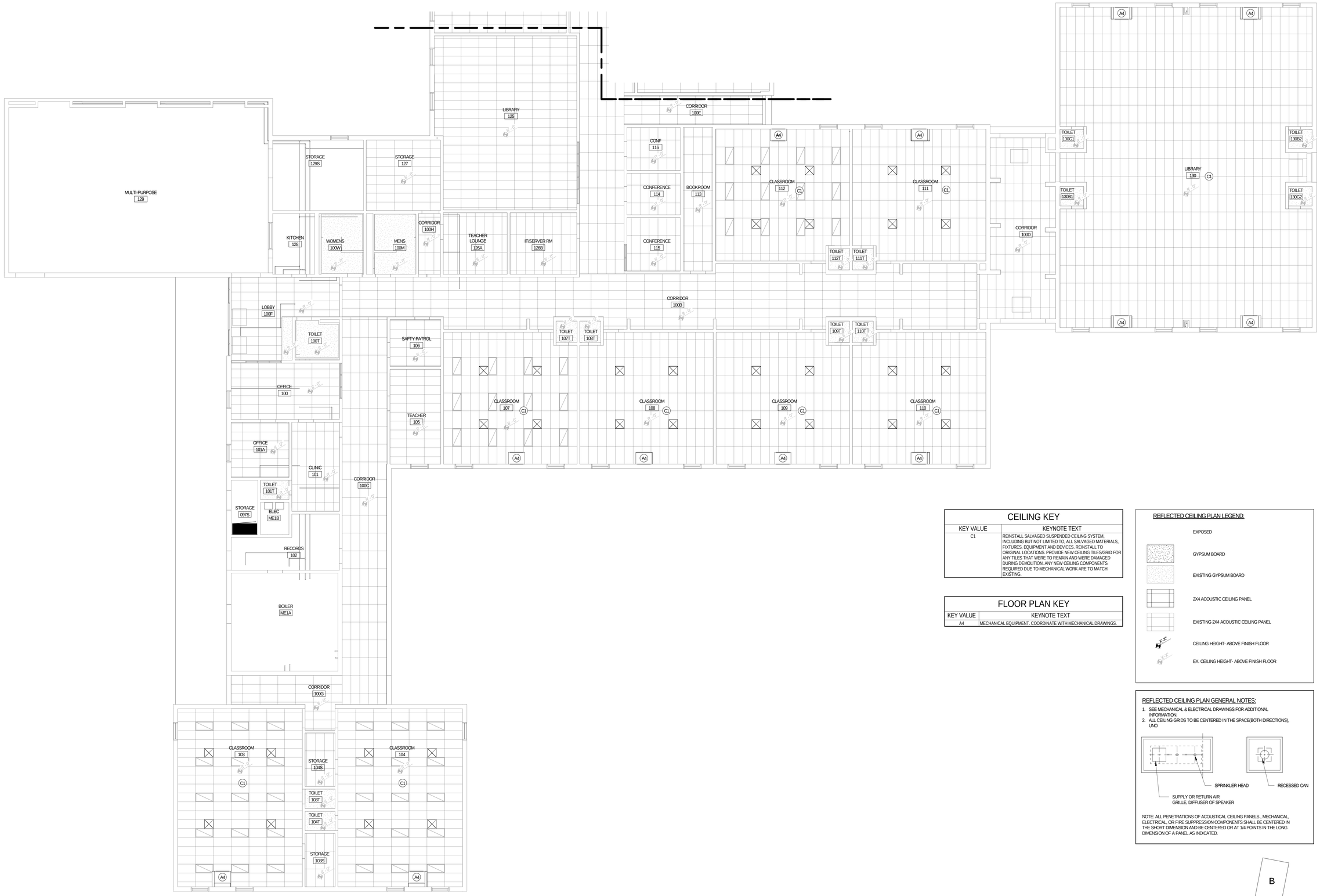
CHECKED BY: Checker APPROVED BY: Approver



REFLECTED CEILING PLAN - AREA A
1/8" = 1'-0"

CEILING KEY

KEY VALUE	KEYNOTE TEXT
C1	REINSTALL SALVAGED SUSPENDED CEILING SYSTEM, INCLUDING BUT NOT LIMITED TO, ALL SALVAGED MATERIALS, FIXTURES, EQUIPMENT AND DEVICES. REINSTALL TO ORIGINAL LOCATIONS. PROVIDE NEW CEILING TILES/GRID FOR ANY TILES THAT WERE TO REMAIN AND WERE DAMAGED DURING DEMOLITION. ANY NEW CEILING COMPONENTS REQUIRED DUE TO MECHANICAL WORK ARE TO MATCH EXISTING.

FLOOR PLAN KEY

KEY VALUE	KEYNOTE TEXT
A4	MECHANICAL EQUIPMENT. COORDINATE WITH MECHANICAL DRAWINGS.

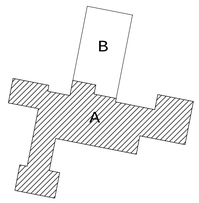
REFLECTED CEILING PLAN LEGEND:

- EXPOSED
- GYPSUM BOARD
- EXISTING GYPSUM BOARD
- 2X4 ACOUSTIC CEILING PANEL
- EXISTING 2X4 ACOUSTIC CEILING PANEL
- X'-X" CEILING HEIGHT- ABOVE FINISH FLOOR
- X'-X" EX. CEILING HEIGHT- ABOVE FINISH FLOOR

REFLECTED CEILING PLAN GENERAL NOTES:

1. SEE MECHANICAL & ELECTRICAL DRAWINGS FOR ADDITIONAL INFORMATION.
2. ALL CEILING GRIDS TO BE CENTERED IN THE SPACE(BOTH DIRECTIONS), UNO

NOTE: ALL PENETRATIONS OF ACOUSTICAL CEILING PANELS , MECHANICAL, ELECTRICAL, OR FIRE SUPPRESSION COMPONENTS SHALL BE CENTERED IN THE SHORT DIMENSION AND BE CENTERED OR AT 1/4 POINTS IN THE LONG DIMENSION OF A PANEL AS INDICATED.



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REFLECTED CEILING PLAN - AREA A

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0117
DATE: 11-NOV-2022
SHEET
A-111A

CONSTRUCTION DOCUMENTS

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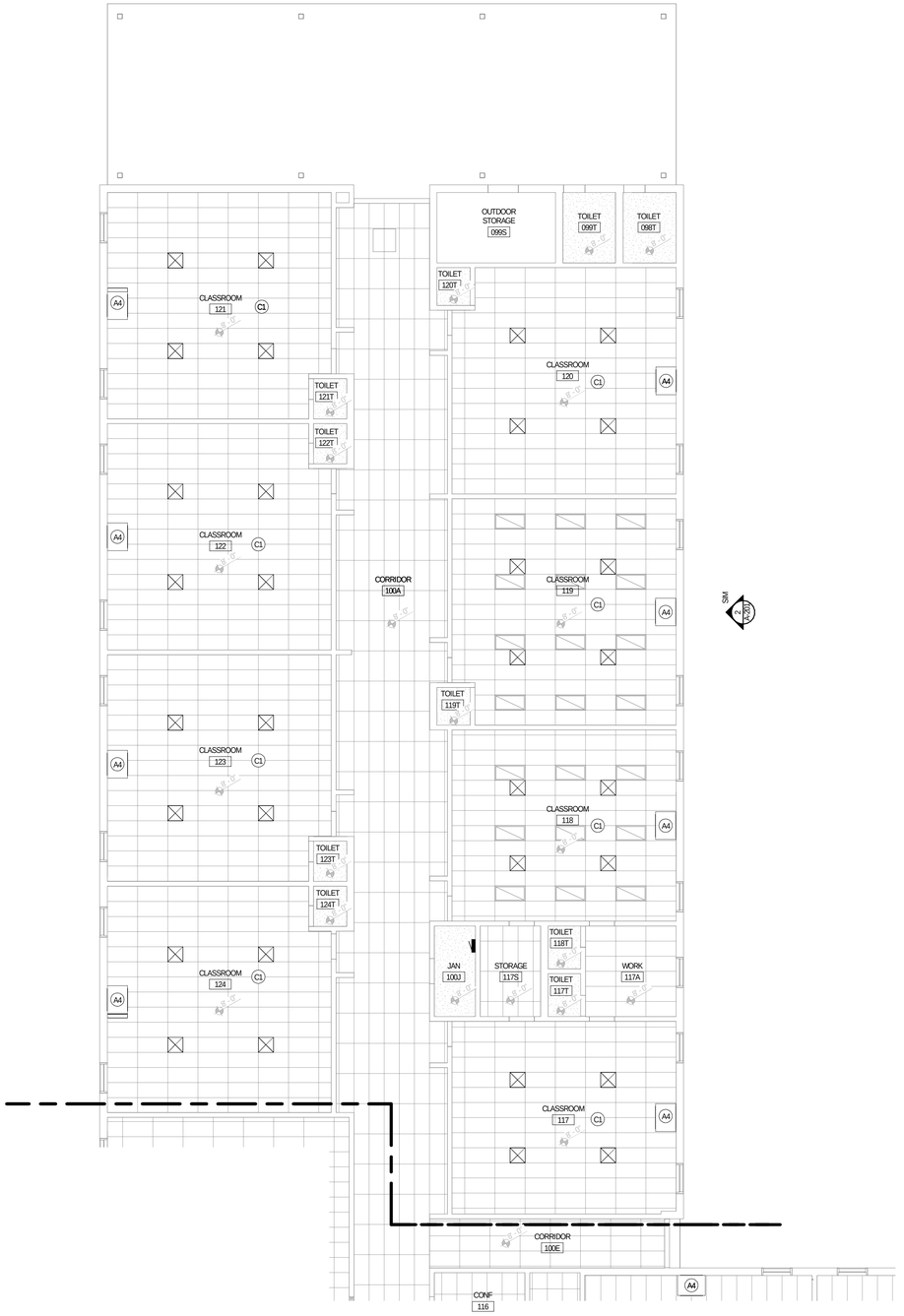


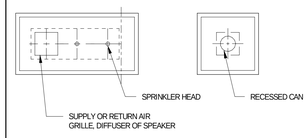
REFLECTED CEILING PLAN - AREA B
1/8" = 1'-0"

REFLECTED CEILING PLAN LEGEND:

- EXPOSED
- GYPSUM BOARD
- EXISTING GYPSUM BOARD
- 2X4 ACOUSTIC CEILING PANEL
- EXISTING 2X4 ACOUSTIC CEILING PANEL
- XX'-XX" CEILING HEIGHT- ABOVE FINISH FLOOR
- EX. CEILING HEIGHT- ABOVE FINISH FLOOR

REFLECTED CEILING PLAN GENERAL NOTES:

1. SEE MECHANICAL & ELECTRICAL DRAWINGS FOR ADDITIONAL INFORMATION.
2. ALL CEILING GRIDS TO BE CENTERED IN THE SPACE(BOTH DIRECTIONS), UNO



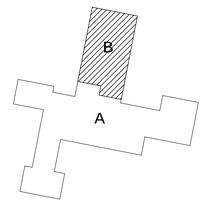
NOTE: ALL PENETRATIONS OF ACOUSTICAL CEILING PANELS , MECHANICAL, ELECTRICAL, OR FIRE SUPPRESSION COMPONENTS SHALL BE CENTERED IN THE SHORT DIMENSION AND BE CENTERED OR AT 1/4 POINTS IN THE LONG DIMENSION OF A PANEL AS INDICATED.

CEILING KEY

KEY VALUE	KEYNOTE TEXT
C1	REINSTALL SALVAGED SUSPENDED CEILING SYSTEM, INCLUDING BUT NOT LIMITED TO, ALL SALVAGED MATERIALS, FIXTURES, EQUIPMENT AND DEVICES. REINSTALL TO ORIGINAL LOCATIONS. PROVIDE NEW CEILING TILES/GRID FOR ANY TILES THAT WERE TO REMAIN AND WERE DAMAGED DURING DEMOLITION. ANY NEW CEILING COMPONENTS REQUIRED DUE TO MECHANICAL WORK ARE TO MATCH EXISTING.

FLOOR PLAN KEY

KEY VALUE	KEYNOTE TEXT
A4	MECHANICAL EQUIPMENT. COORDINATE WITH MECHANICAL DRAWINGS.



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REFLECTED CEILING PLAN - AREA B

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0117
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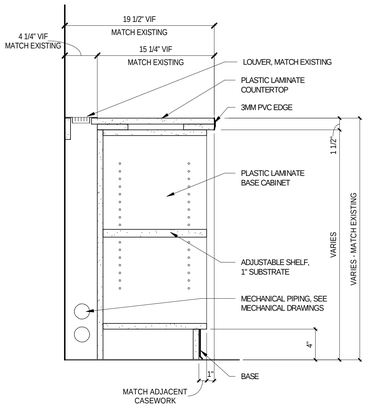
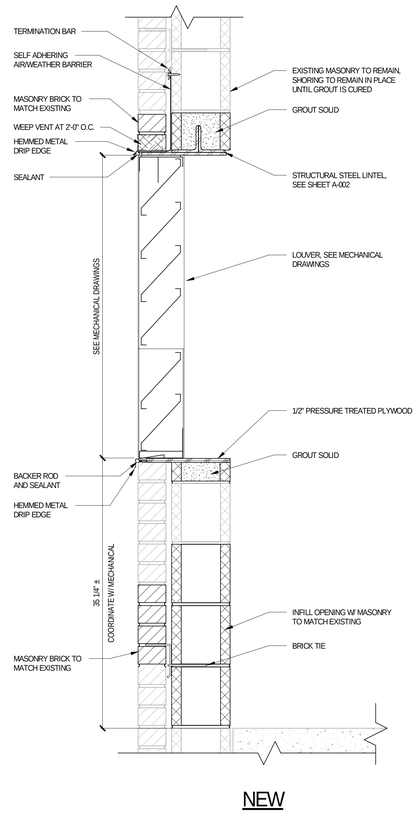
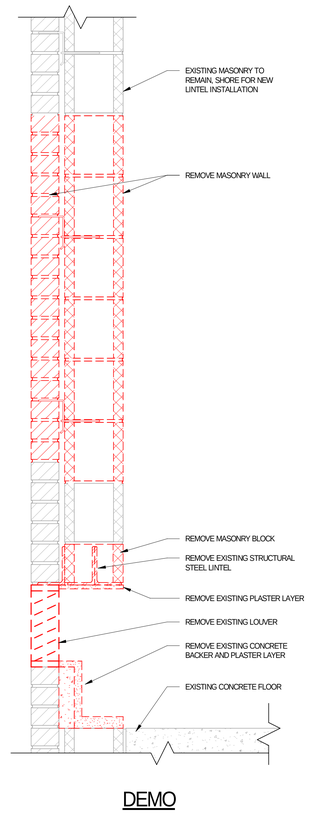


6 A-201 OPEN BASE CABINET
1 1/2" = 1'-0"



NEW



DEMO

5 A-201 WALL SECTION - THROUGH LOUVER
1 1/2" = 1'-0"

DEMOLITION KEY

KEY VALUE	KEYNOTE TEXT
D3	REMOVE EXISTING LOUVER AND STRUCTURAL STEEL LINTEL AS REQUIRED FOR NEW WORK. INCLUDE, BUT NOT LIMITED TO ALL TRIM, ANCHORS, SEALANTS, ETC. PREPARE OPENING FOR NEW WORK. ALL MASONRY REPAIR WORK IS TO BE TOOTHED INTO EXISTING.
D4	SAWCUT AND REMOVE EXTERIOR WALL FOR NEW OPENING AS REQUIRED FOR NEW MECHANICAL WORK. PATCH AND REPAIR TO MATCH EXISTING. ALL MASONRY REPAIR WORK IS TO BE TOOTHED INTO EXISTING.

FLOOR PLAN KEY

KEY VALUE	KEYNOTE TEXT
A1	PROVIDE NEW LOUVER AND STEEL LINTEL AS REQUIRED FOR NEW MECHANICAL EQUIPMENT. REFER TO THE MISCELLANEOUS STEEL LINTEL SCHEDULE FOR INFORMATION ON THE NEW STEEL LINTEL. COORDINATE LOUVER SIZE WITH MECHANICAL DRAWINGS. FINAL PLACEMENT OF LOUVER IS DETERMINED BY MECHANICAL EQUIPMENT. PATCH AND REPAIR ALL ADJACENT WALL INFILL TO MATCH EXISTING. ALL MASONRY REPAIR WORK IS TO BE TOOTHED INTO EXISTING.
A2	INFILL EXISTING WALL OPENING WITH NEW MATERIALS TO MATCH EXISTING. STEEL LINTELS TO REMAIN. ALL MASONRY REPAIR WORK IS TO BE TOOTHED INTO EXISTING. PATCH AND REPAIR ALL SURFACES AS REQUIRED FOR PROPER INSTALLATION OF NEW FINISHES.
A3	CABINET MODIFICATIONS: REPLACE ANY TEMPORARY CABINET SUPPORT WITH A FINISHED END PANEL THAT PROVIDES THE ABILITY TO MEET OR EXCEED THE EXISTING SUPPORT. ALL EXPOSED EXISTING TRIM SHALL BE GRINDED SMOOTH TO ENSURE NO SHARP EDGES. CONTRACTOR TO REVIEW EACH EXISTING CONDITION PRIOR TO BIDDING AND AGAIN AT THE START OF CONSTRUCTION AS THEY VARY FROM ROOM TO ROOM.
A4	MECHANICAL EQUIPMENT. COORDINATE WITH MECHANICAL DRAWINGS.
A8	NEW WALL BASE TO MATCH EXISTING.
A9	PAINT WALLS TO MATCH EXISTING.
A10	NEW METAL FILLER PANEL AND TOP TO MATCH ADJACENT CASEWORK PROFILE AND OVERALL HEIGHT. FILLER PANEL COLOR IS TO MATCH ADJACENT MECHANICAL EQUIPMENT. REINFORCE FILLER PANEL TO ENSURE OIL CANNING WILL NOT OCCUR AND IS NOT EASILY DAMAGED. PROVIDE ISOLATION MATERIAL WHERE METAL FILLER PANEL AND TOP MEET NEW MECHANICAL UNIT AND EXISTING CASEWORK AND COUNTERTOP TO REMAIN. CONTRACTOR TO REVIEW EACH EXISTING CONDITION PRIOR TO BIDDING AND AGAIN AT THE START OF CONSTRUCTION AS THEY VARY FROM ROOM TO ROOM AND EACH LOCATION WILL BE CUSTOM IN OVERALL DIMENSIONS.
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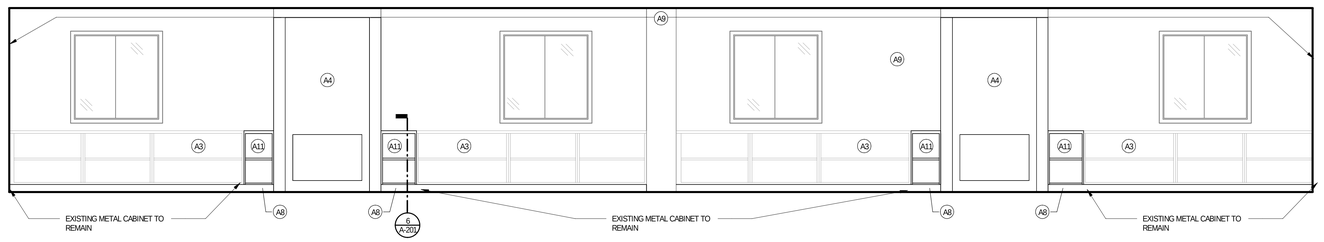
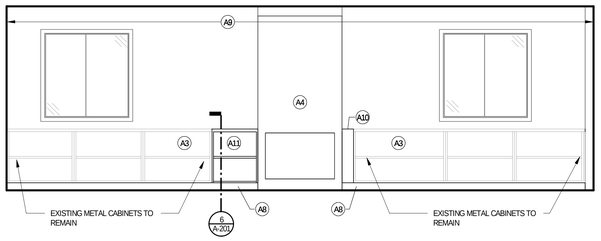
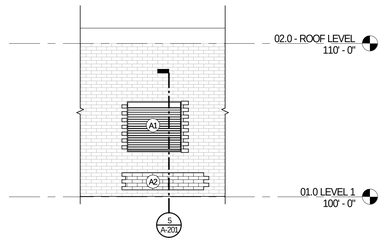


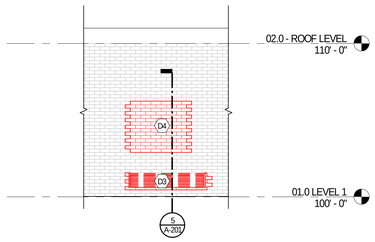
4 A-101A CLASSROOM 130 - NORTH
3/8" = 1'-0"



3 A-101B CLASSROOM 117 - EAST
3/8" = 1'-0"



2 A-101A EXTERIOR ELEVATION - LOUVER NEW
1/4" = 1'-0"



1 AD101A EXTERIOR ELEVATION - LOUVER DEMO
1/4" = 1'-0"

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ELEVATIONS & DETAILS

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DESIGNED BY: Designer
DRAWN BY: Drafter APPROVED BY: Approver

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MECHANICAL ABBREVIATIONS & SYMBOLS LEGEND

ABBREVIATION	DESCRIPTION
AC	ALTERNATING CURRENT
ACH	AIR CHANGES PER HOUR
ACM	ASBESTOS CONTAINING MATERIALS
ACU	AIR CONDITIONING UNIT
ADJ	ADJUSTABLE
AEE	ASSOCIATION OF ENERGY ENGINEERS
AFD	ADJUSTABLE FREQUENCY DRIVE
AFF	ABOVE FINISHED FLOOR
AFUE	ANNUAL FUEL EFFICIENCY RATIO
AHU	AIR HANDLING UNIT
AI	ANALOG INPUT
AO	ANALOG OUTPUT
ASHRAE	AMERICAN SOCIETY OF HEATING REFRIGERATION AND AIR CONDITIONING ENGINEERS
ASME	AMERICAN SOCIETY OF MECHANICAL ENGINEERS
AWT	AVERAGE WATER TEMPERATURE
B	BOILER
BAS	BUILDING AUTOMATION SYSTEM
BCA	BUILDING COMMISSIONING ASSOCIATION
BCU	BLOWER COIL UNIT
BD	BALANCING DAMPER
BHP	BRAKE HORSEPOWER
BI	BINARY INPUT
BO	BINARY OUTPUT
BOM	BILL OF MATERIALS
BTU	BRITISH THERMAL UNIT
BTUH	BRITISH THERMAL UNIT PER HOUR
CAV	CONSTANT AIR VOLUME
CD	CONDENSATE DRAIN
CDD	COOLING DEGREE DAYS
CEM	CERTIFIED ENERGY MANAGER
CFC	CHLORO-FLUORO-CARBON
CFM	CUBIC FEET PER MINUTE
CH	CHILLER
CHW	CHILLED WATER
CHWP	CHILLED WATER SYSTEM PUMP
CHWR	CHILLED WATER RETURN
CHWS	CHILLED WATER SUPPLY
CLF	COOLING LOAD FACTOR
CLTD	COOLING LOAD TEMPERATURE DIFFERENCE
COP	COEFFICIENT OF PERFORMANCE
CRAC	COMPUTER ROOM AIR CONDITIONER
CT	COOLING TOWER
CU	CONDENSING UNIT
CUH	CABINET UNIT HEATER
CV	CONSTANT VOLUME
CWP	CONDENSER WATER PUMP
CWR	CONDENSER WATER RETURN
CWS	CONDENSER WATER SUPPLY
DA	DISCHARGE AIR
DB	DRY BULB
DC	DIRECT CURRENT
DCV	DEMAND CONTROLLED VENTILATION
DD	DEGREE DAY
DDC	DIRECT DIGITAL CONTROL
DL	DISCHARGE LINE - REFRIGERANT
DI	DIGITAL INPUT
DO	DIGITAL OUTPUT
DP	DIFFERENTIAL PRESSURE
DRG	DIFFUSERS, REGISTERS, & GRILLES
DX	DIRECT EXPANSION
EA	EXHAUST AIR
EAT	ENTERING AIR TEMPERATURE
ECM	ELECTRONICALLY COMMUTATED MOTOR
EER	ENERGY EFFICIENCY RATIO
EF	EXHAUST FAN
EG	EXHAUST GRILLE
EH	EXHAUST HOOD

ABBREVIATION	DESCRIPTION
EL	ELEVATION
EMS	ENERGY MANAGEMENT SYSTEM
ESP	EXTERNAL STATIC PRESSURE
ET	EXPANSION TANK
EUH	ELECTRIC UNIT HEATER
EWT	ENTERING WATER TEMPERATURE
EX	EXISTING
F	FAHRENHEIT
FCU	FAN COIL UNIT
FLA	FULL LOAD AMPERAGE
FPM	FEET PER MINUTE
FS	FLOW SWITCH
FT	FEET
FT-HD	FOOT OF HEAD PRESSURE
FTR	FINNED TUBE RADIATORS
G	GASOLINE
GA	GAUGE
GPM	GALLONS PER MINUTE
GPR	GAS PRESSURE REGULATOR
GUI	GRAPHICAL UNIT INTERFACE
H	HOOD
HCC	HYDRONIC CEILING CASSETTE
HCFC	HYDRO-CHLORO-FLUORO-CARBON
HD	HEAD PRESSURE
HDD	HEATING DEGREE DAYS
HEPA	HIGH EFFICIENCY PARTICULATE ARRESTANCE
HFC	HYDRO-FLUORO-CARBON
HHW	HEATING HOT WATER
HHWP	HEATING HOT WATER PUMP
HHWR	HEATING HOT WATER RETURN
HHWS	HEATING HOT WATER SUPPLY
HL	HIGH LIMIT
HPU	HEAT PUMP UNIT
HP	HORSEPOWER
HPR	HEAT PUMP RETURN
HPS	HEAT PUMP SUPPLY
HRU	HEAT RECOVERY UNIT
HRV	HEAT RECOVERY VENTILATOR
HVAC	HEATING, VENTILATION, & AIR CONDITIONING
HX	HEAT EXCHANGER
HZ	HERTZ (FREQUENCY)
IA	INTAKE AIR
IAQ	INDOOR AIR QUALITY
IF	INLINE FAN
IH	INTAKE HOOD
IMC	INTERNATIONAL MECHANICAL CODE
IN	INCHES
IN-WC	INCHES OF WATER COLUMN PRESSURE
IR	INFRA-RED
IU	INDOOR UNIT
kW	KILOWATTS
kWh	KILOWATT HOURS
LAT	LEAVING AIR TEMPERATURE
LF	LINEAR FEET
LH	LATENT HEAT
LL	LIQUID LINE - REFRIGERANT
LMTD	LEAST MEAN TEMPERATURE DIFFERENCE
LP	LOW PRESSURE
LPG	LIQUID PROPANE (GAS)
LPC	LOW PRESSURE STEAM CONDENSATE RETURN
LPS	LOW PRESSURE STEAM SUPPLY
LRA	LOCKED ROTOR AMPERAGE
LWT	LEAVING WATER TEMPERATURE
MA	MIXED AIR
MAT	MIXED AIR TEMPERATURE
MAU	MAKE-UP AIR UNIT
MBH	THOUSAND BTUH
MCA	MINIMUM CIRCUIT AMPACITY

ABBREVIATION	DESCRIPTION
MFR	MANUFACTURER
MHP	MOTOR HORSEPOWER
MMC	MICHIGAN MECHANICAL CODE
MOCP	MAXIMUM OVERCURRENT PROTECTION
MPC	MEDIUM PRESSURE STEAM CONDENSATE RETURN
MPS	MEDIUM PRESSURE STEAM SUPPLY
MR	MANUFACTURER'S RECOMMENDATIONS
MZ	MULTI-ZONE
NA	NOT APPLICABLE
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
NPSH	NET POSITIVE SUCTION HEAD
NTS	NOT TO SCALE
OA	OUTDOOR AIR
OAP	OUTDOOR AIR PERCENTAGE
OAT	OUTDOOR AIR TEMPERATURE
OZ	OUNCE
P	PUMP
PD	PRESSURE DROP
PH	PRE-HEAT
PID	PROPORTIONAL-INTEGRAL-DERIVATIVE
PRV	PRESSURE RELIEF VALVE
PSI	POUNDS PER SQUARE INCH
PTAC	PACKAGED TERMINAL AIR CONDITIONER
RA	RETURN AIR
RAT	RETURN AIR TEMPERATURE
RF	RETURN FAN
RG	RETURN GRILLE
RH	RELATIVE HUMIDITY
RHT	RE-HEAT
RLA	RUNNING LOAD AMPERAGE
RPM	REVOLUTIONS PER MINUTE
RTU	ROOFTOP UNIT
SA	SUPPLY AIR
SAT	SUPPLY AIR TEMPERATURE
SC	SHADING COEFFICIENT
SD	SUPPLY DIFFUSER
SEER	SEASONAL ENERGY EFFICIENCY RATIO
SF	SUPPLY FAN
SG	SUPPLY GRILLE
SH	SENSIBLE HEAT
SHR	SENSIBLE HEAT RATIO
SL	SUCTION LINE - REFRIGERANT
SMACNA	SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION
SOO	SEQUENCE OF OPERATION
SP	STATIC PRESSURE
T	TEMPERATURE
TSTAT	THERMOSTAT
TAB	TEST AND BALANCE
TD	TEMPERATURE DIFFERENTIAL
TOD	TIME OF DAY
TONS	TONS OF REFRIGERATION (1 TON = 12,000 BTU)
TSP	TOTAL STATIC PRESSURE
TU	TERMINAL UNIT
TXV	THERMOSTATIC EXPANSION VALVE
TYP	TYPICAL
UH	UNIT HEATER
UNO	UNLESS NOTED OTHERWISE
UV	UNIT VENTILATOR
VAV	VARIABLE AIR VOLUME BOX
VD	VOLUME DAMPER
VFD	VARIABLE FREQUENCY DRIVE
VRF	VARIABLE REFRIGERANT FLOW
VSD	VARIABLE SPEED DRIVE
VUV	VERTICAL UNIT VENTILATOR
WB	WET BULB
WC	WATER COLUMN

SYMBOL	DESCRIPTION
PIPING	
HPS	HIGH PRESSURE STEAM
MPS	MEDIUM PRESSURE STEAM
LPS	LOW PRESSURE STEAM
HPC	HIGH PRESSURE STEAM CONDENSATE
MPC	MEDIUM PRESSURE STEAM CONDENSATE
LPC	LOW PRESSURE STEAM CONDENSATE
BBD	BOILER BLOWDOWN
PC	PUMPED CONDENSATE
VPD	VACUUM PUMP DISCHARGE
MU	MAKE-UP WATER
ATV	ATMOSPHERIC VENT
FO	FUEL OIL
HHWS	HEATING HOT WATER SUPPLY
HHWR	HEATING HOT WATER RETURN
CA	COMPRESSED AIR
VAC	VACUUM (AIR)
EX	EXISTING
	DEMOLITION PIPING
LL	LIQUID LINE (REFRIGERANT)
SL	SUCTION LINE (REFRIGERANT)
DL	DISCHARGE LINE (REFRIGERANT)
BS	BRINE SUPPLY
BR	BRINE RETURN
CWS	CONDENSER WATER SUPPLY
CWR	CONDENSER WATER RETURN
CHWS	CHILLED WATER SUPPLY
CHWR	CHILLED WATER RETURN
FILL	FILL LINE
H	HUMIDIFICATION LINE
D	DRAIN
HPWS	HEAT PUMP WATER SUPPLY
HPWR	HEAT PUMP WATER RETURN
COILS	
	COOLING COIL
	HEATING COIL
	ELECTRIC COIL
	HUMIDIFIER
VALVES	
	AIR LINE
	BALL VALVE
	BUTTERFLY VALVE
	DIAPHRAGM VALVE
	GATE VALVE
	GATE VALVE (ANGLE)
	PLUG VALVE
	THREE WAY VALVE
	CHECK VALVE
	PRESSURE REGULATING VALVE
	RELIEF VALVE
VALVE ACTUATORS	
	LEVER
	NON-RISING STEM
	OUTSIDE STEM & YOKE
G	GEAR
M	PNUEMATIC MOTOR ACTUATOR
M	ELECTRIC MOTOR ACTUATOR
	ELECTRIC SOLENOID ACTUATOR
PIPE FITTINGS	
	TRANSITION
	CAP
	ELBOW
	ELBOW UP
	ELBOW DOWN
	TEE
	TEE UP
	TEE DOWN
	UNION

SYMBOL	DESCRIPTION
PIPE SPECIALTIES	
AAV	AUTOMATIC AIR VENT
	MANUAL AIR VENT
	PIPE GUIDE
	PIPE ANCHOR
	MAIN PIPE ANCHOR
	BALL JOINT
	EXPANSION JOINT
	EXPANSION LOOP
	FLEXIBLE CONNECTOR
	ORIFICE FLOWMETER
	VENTURI FLOWMETER
FS	FLOW SWITCH
H	HANGER ROD
	PRESSURE GAGE
PS	PRESSURE SWITCH
	PUMP
	STRAINER
	THERMOMETER
EQUIPMENT	
	CENTRIFUGAL FAN
	PROPELLER FAN
	INTAKE ROOF VENTILATOR
	EXHAUST ROOF VENTILATOR
	LOUVERED ROOF VENTILATOR
	VANEAXIAL FAN
	VARIABLE AIR VOLUME BOX
DUCTWORK	
SA	SUPPLY AIR DUCTWORK
RA	RETURN AIR DUCTWORK
EA	EXHAUST AIR DUCTWORK
OA	OUTSIDE AIR DUCTWORK
12"x12" SA	RECTANGULAR DUCTWORK
12"Ø SA	ROUND DUCTWORK
	MITERED RECTANGULAR ELBOW
	MITERED RECTANGULAR ELBOW WITH TURNING VANES
	RADIUS RECTANGULAR OR ROUND ELBOW
	TRANSITION
	RECTANGULAR DUCTWORK UP
	RECTANGULAR DUCTWORK DOWN
	ROUND DUCTWORK UP
	ROUND DUCTWORK DOWN
	FLEXIBLE DUCTWORK CONNECTOR
	LINED DUCTWORK
	INSULATED DUCTWORK
	FLEXIBLE DUCTWORK
DAMPERS	
	BALANCING DAMPER
	FIRE DAMPER
	SMOKE DAMPER
DRG	
	SUPPLY AIR CEILING DIFFUSER
	RETURN AIR CEILING GRILLE
	EXHAUST AIR CEILING GRILLE
	SIDEWALL SUPPLY GRILLE
	SIDEWALL RETURN / EXHAUST GRILLE
	LINEAR DIFFUSER
CONTROLS	
T	THERMOSTAT
P	PRESSURE SENSOR
O	OXYGEN SENSOR
CO	CARBON DIOXIDE SENSOR
CO	CARBON MONOXIDE SENSOR
S	TEMPERATURE SENSOR

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MECHANICAL LEGENDS

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CONSTRUCTION DOCUMENTS

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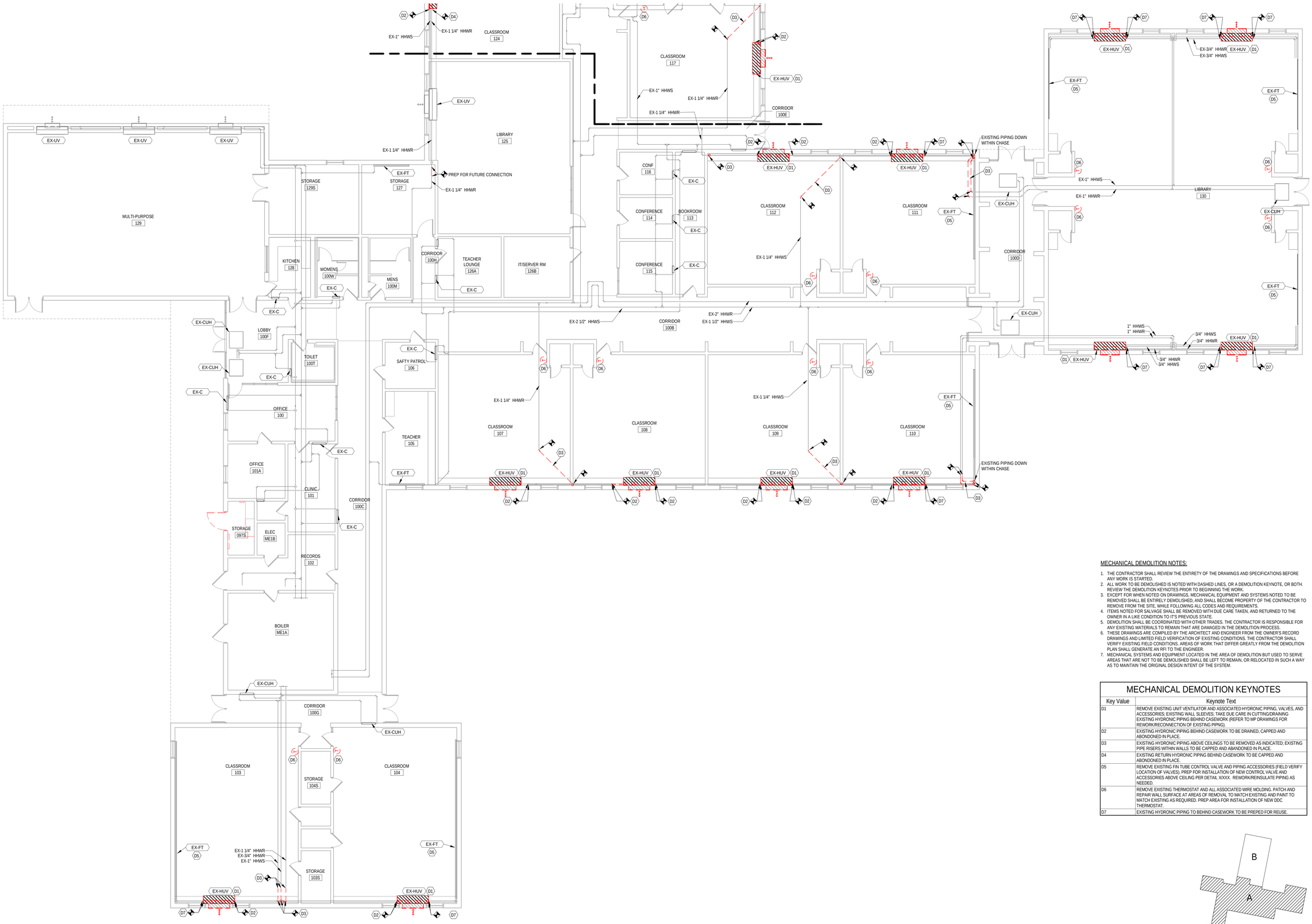
DESIGNED BY: Designer
CHECKED BY: Checker APPROVED BY: Approver



DEMOLITION PLAN - FIRST LEVEL - AREA A
1/8" = 1'-0"

MECHANICAL DEMOLITION NOTES:

1. THE CONTRACTOR SHALL REVIEW THE ENTIRETY OF THE DRAWINGS AND SPECIFICATIONS BEFORE ANY WORK IS STARTED.
2. ALL WORK TO BE DEMOLISHED IS NOTED WITH DASHED LINES, OR A DEMOLITION KEYNOTE, OR BOTH. REVIEW THE DEMOLITION KEYNOTES PRIOR TO BEGINNING THE WORK.
3. EXCEPT FOR WHEN NOTED ON DRAWINGS, MECHANICAL EQUIPMENT AND SYSTEMS NOTED TO BE REMOVED SHALL BE ENTIRELY DEMOLISHED, AND SHALL BECOME PROPERTY OF THE CONTRACTOR TO REMOVE FROM THE SITE, WHILE FOLLOWING ALL CODES AND REQUIREMENTS.
4. ITEMS NOTED FOR SALVAGE SHALL BE REMOVED WITH DUE CARE TAKEN, AND RETURNED TO THE OWNER IN A LIKE CONDITION TO IT'S PREVIOUS STATE.
5. DEMOLITION SHALL BE COORDINATED WITH OTHER TRADES. THE CONTRACTOR IS RESPONSIBLE FOR ANY EXISTING MATERIALS TO REMAIN THAT ARE DAMAGED IN THE DEMOLITION PROCESS.
6. THESE DRAWINGS ARE COMPILED BY THE ARCHITECT AND ENGINEER FROM THE OWNER'S RECORD DRAWINGS AND LIMITED FIELD VERIFICATION OF EXISTING CONDITIONS. THE CONTRACTOR SHALL VERIFY EXISTING FIELD CONDITIONS. AREAS OF WORK THAT DIFFER GREATLY FROM THE DEMOLITION PLAN SHALL GENERATE AN RFI TO THE ENGINEER.
7. MECHANICAL SYSTEMS AND EQUIPMENT LOCATED IN THE AREA OF DEMOLITION BUT USED TO SERVE AREAS THAT ARE NOT TO BE DEMOLISHED SHALL BE LEFT TO REMAIN, OR RELOCATED IN SUCH A WAY AS TO MAINTAIN THE ORIGINAL DESIGN INTENT OF THE SYSTEM.

MECHANICAL DEMOLITION KEYNOTES

Key Value	Keynote Text
D1	REMOVE EXISTING UNIT VENTILATOR AND ASSOCIATED HYDRONIC PIPING, VALVES, AND ACCESSORIES; EXISTING WALL SLEEVES; TAKE DUE CARE IN CUTTING/DRAINING EXISTING HYDRONIC PIPING BEHIND CASEWORK (REFER TO MP DRAWINGS FOR REWORK/RECONNECTION OF EXISTING PIPING).
D2	EXISTING HYDRONIC PIPING BEHIND CASEWORK TO BE DRAINED, CAPPED AND ABONDONED IN PLACE.
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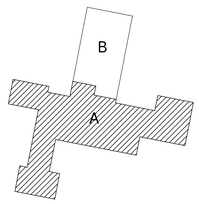
D7	EXISTING HYDRONIC PIPING TO BEHIND CASEWORK TO BE PREPED FOR REUSE.



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DEMOLITION PLAN - FIRST LEVEL - AREA A

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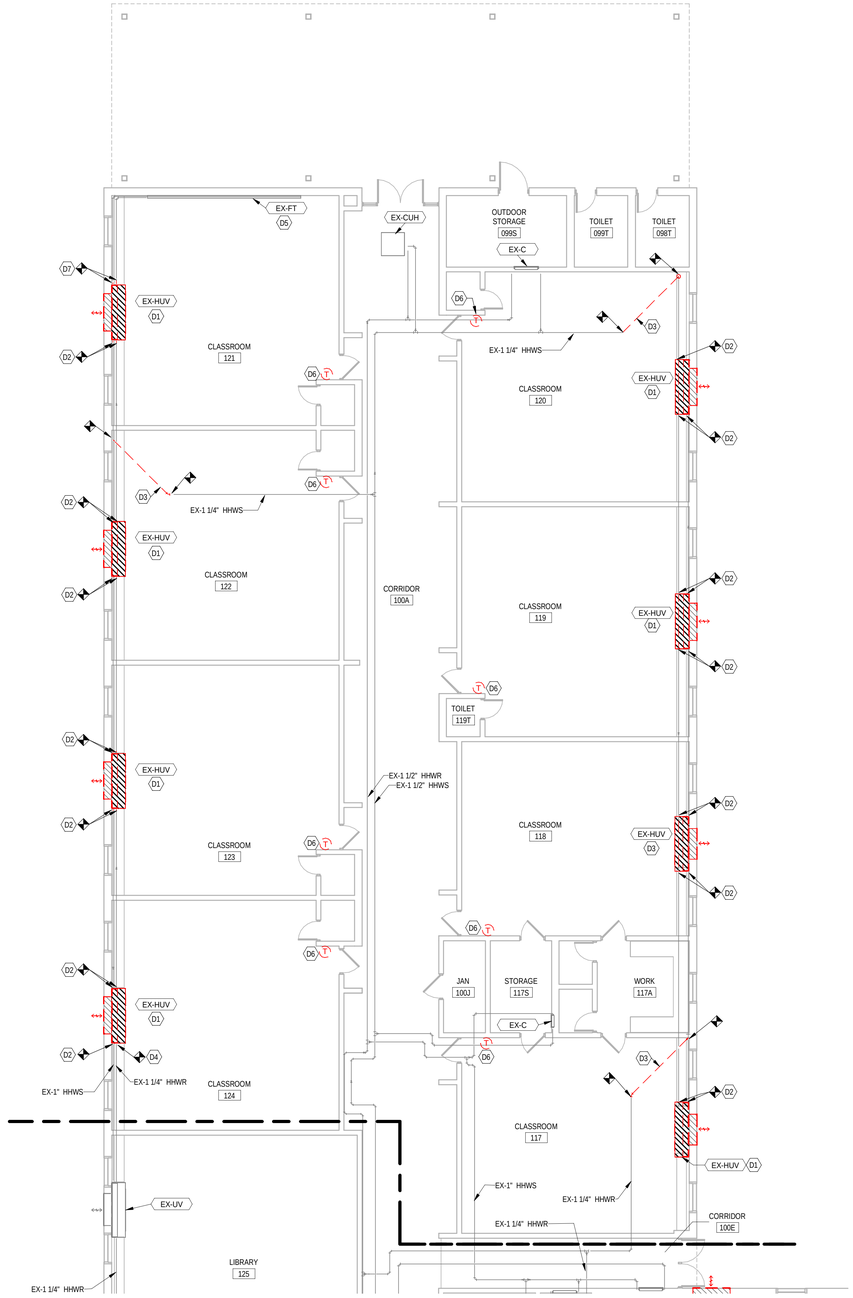

DEMOLITION PLAN - FIRST LEVEL - AREA B
1/8" = 1'-0"

MECHANICAL GENERAL NOTES:

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MECHANICAL KEYNOTES

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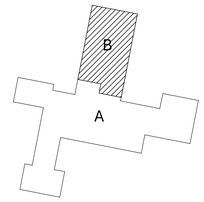

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DEMOLITION PLAN - FIRST LEVEL - AREA B

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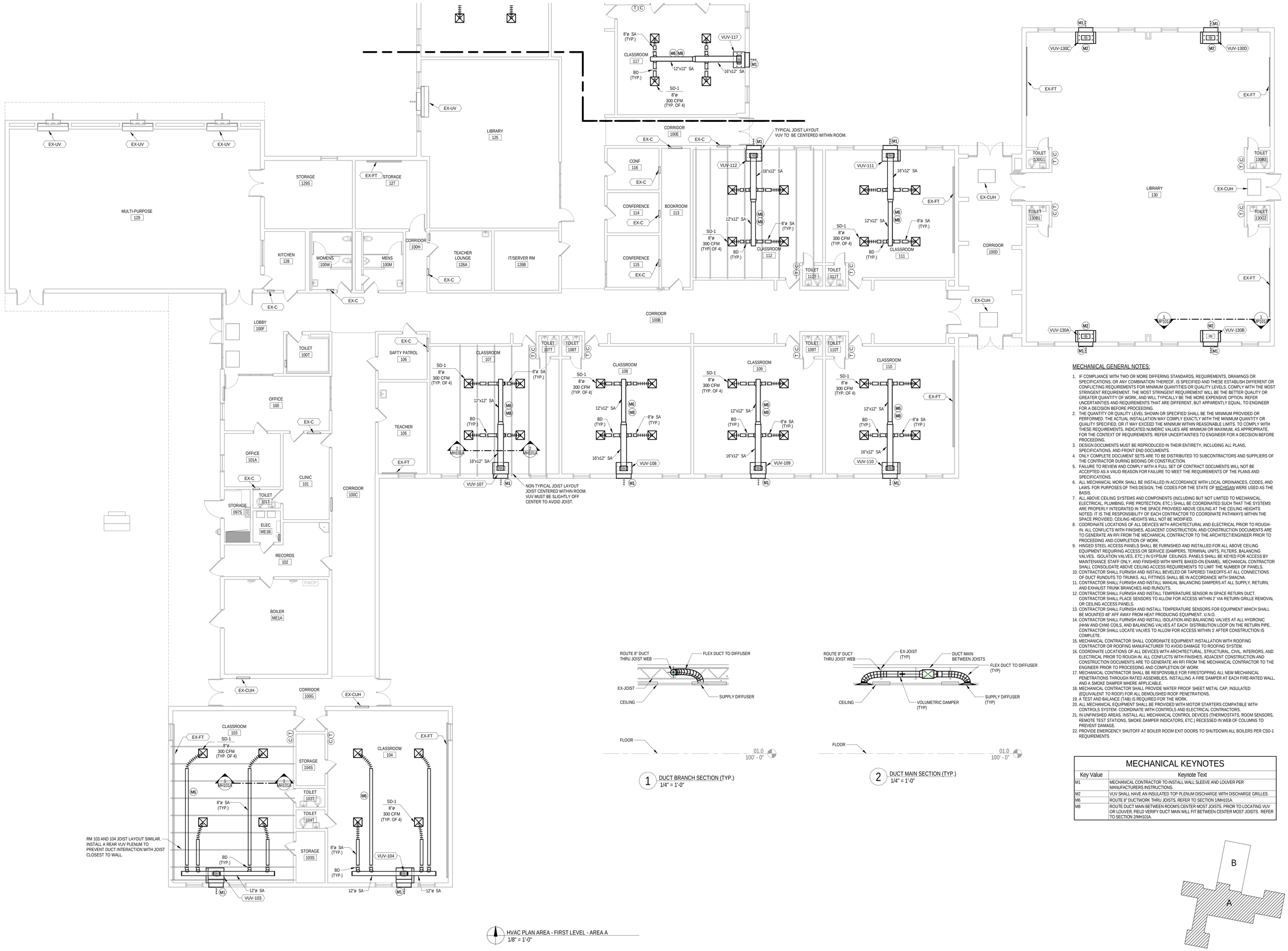

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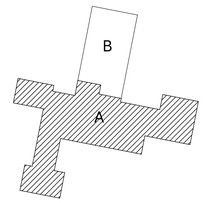
MECHANICAL KEYNOTES

Key Value	Keynote Text
M1	MECHANICAL CONTRACTOR TO INSTALL WALL SLEEVE AND LOUVER PER MANUFACTURERS INSTRUCTIONS.
M2	VUV SHALL HAVE AN INSULATED TOP PLENUM DISCHARGE WITH DISCHARGE GRILLES.
M6	ROUTE 8" DUCTWORK THRU JOISTS. REFER TO SECTION 1/MH101A.
M8	ROUTE DUCT MAIN BETWEEN ROOM'S CENTER MOST JOISTS. PRIOR TO LOCATING VUV OR LOUVER, FIELD VERIFY DUCT MAIN WILL FIT BETWEEN CENTER MOST JOISTS. REFER TO SECTION 2/MH101A.

1 DUCT BRANCH SECTION (TYP.)
1/4" = 1'-0"

2 DUCT MAIN SECTION (TYP.)
1/4" = 1'-0"

HVAC PLAN AREA - FIRST LEVEL - AREA A
1/8" = 1'-0"



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HVAC PLAN - FIRST LEVEL - AREA A

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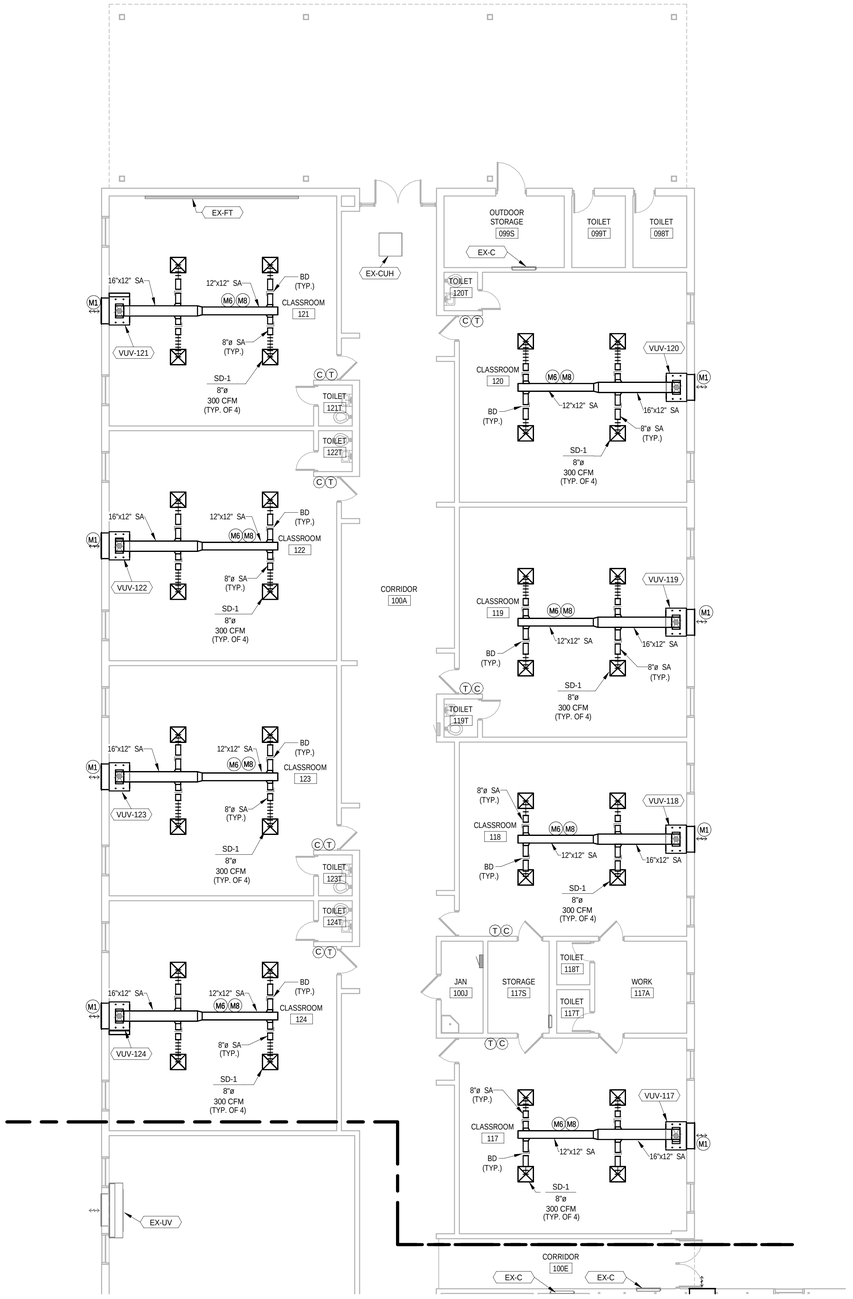

HVAC PLAN AREA - FIRST LEVEL - AREA B
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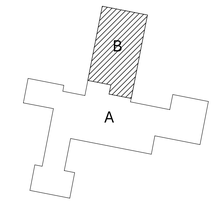
MECHANICAL KEYNOTES

Key Value	Keynote Text
M1	MECHANICAL CONTRACTOR TO INSTALL WALL SLEEVE AND LOUVER PER MANUFACTURERS INSTRUCTIONS.
M6	ROUTE 8" DUCTWORK THRU JOISTS. REFER TO SECTION 1/MH101A.
M8	ROUTE DUCT MAIN BETWEEN ROOM'S CENTER MOST JOISTS. PRIOR TO LOCATING VUV OR LOUVER, FIELD VERIFY DUCT MAIN WILL FIT BETWEEN CENTER MOST JOISTS. REFER TO SECTION 2/MH101A.



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HVAC PLAN - FIRST LEVEL - AREA B

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0117
DATE: 11-NOV-2022
SHEET
MH101B

CONSTRUCTION DOCUMENTS

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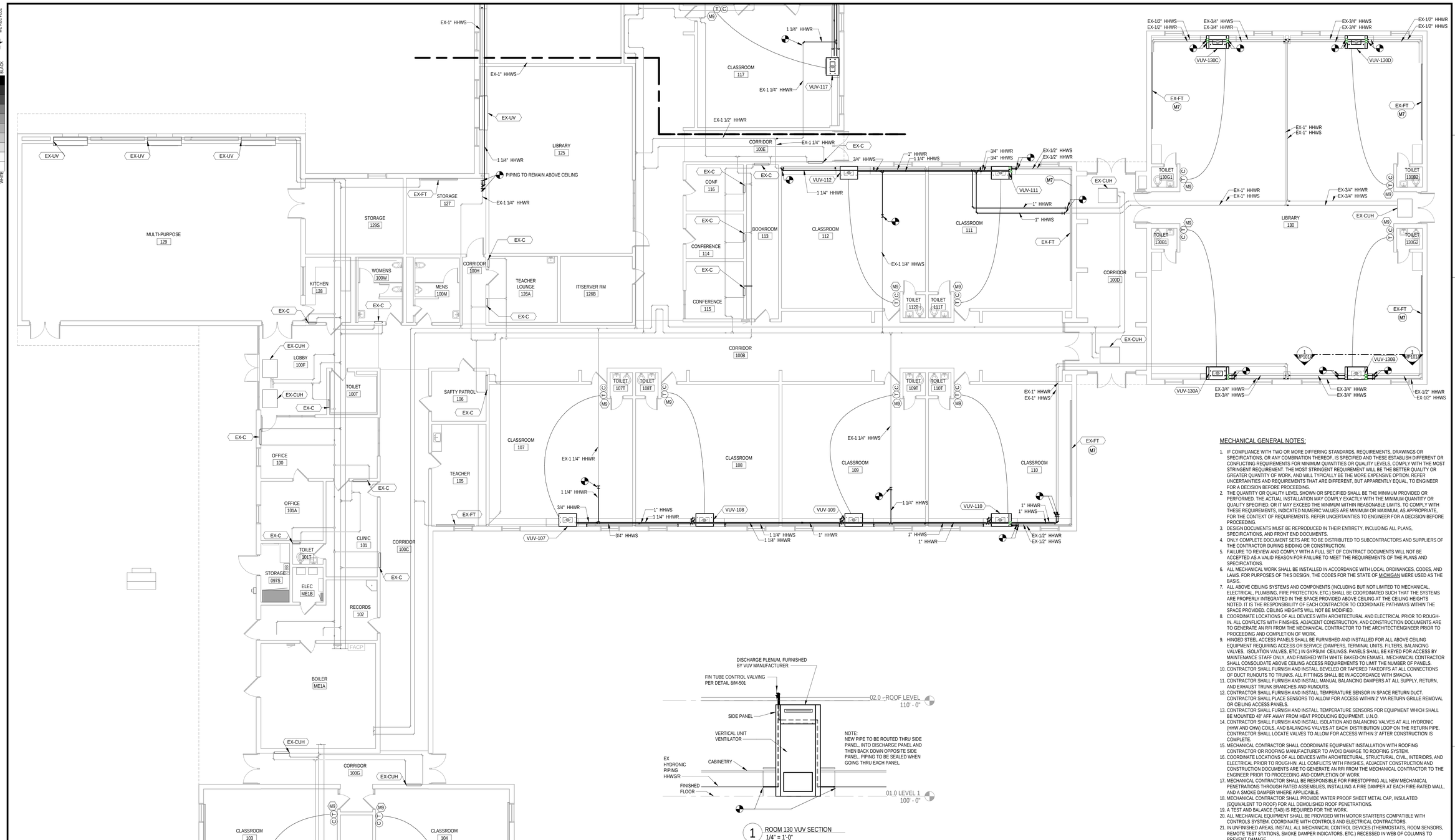
DESIGNED BY: Designer
CHECKED BY: Checker APPROVED BY: Approver



PIPING PLAN - FIRST LEVEL - AREA A
1/8" = 1'-0"

1 ROOM 130 VUV SECTION
1/4" = 1'-0"

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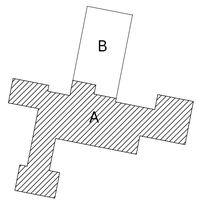

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PIPING PLAN - FIRST LEVEL - AREA A

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0117
DATE: 11-NOV-2022
SHEET
MP101A

CONSTRUCTION DOCUMENTS

THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK
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DESIGNED BY: Designer
CHECKED BY: Checker APPROVED BY: Approver

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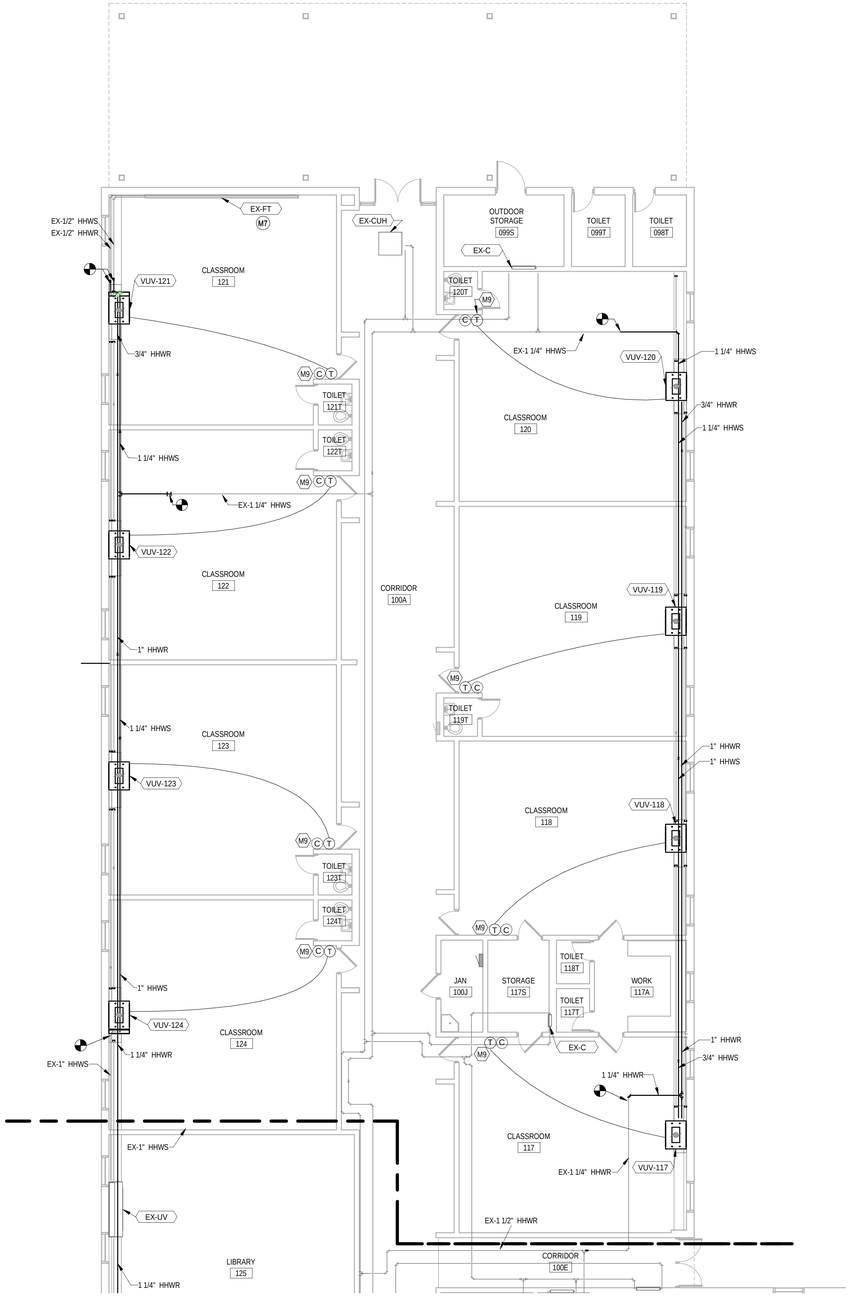

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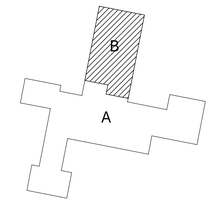

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PIPING PLAN - FIRST LEVEL - AREA B

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0117
DATE: 11-NOV-2022
SHEET
MP101B

CONSTRUCTION DOCUMENTS

11/11/2022 12:24:57 PM
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DESIGNED BY: Designer
CHECKED BY: Checker APPROVED BY: Approver

WE RECYCLE
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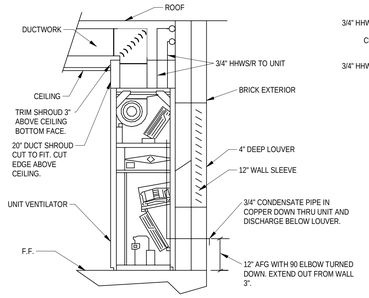
WHITE



1 TYPICAL VERTICAL UNIT VENTILATOR AND LOUVER ELEVATION
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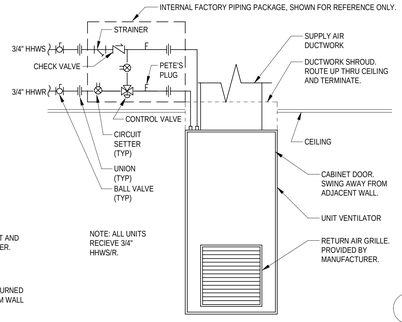

2 HYDRONICS - VERTICAL UNIT VENTILATOR ELEVATION
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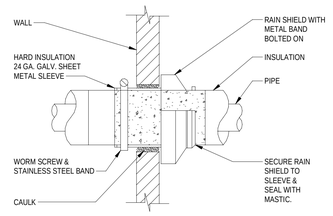
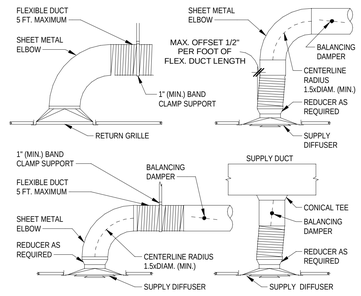
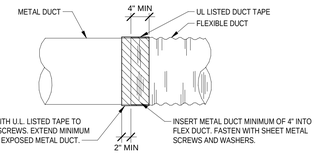


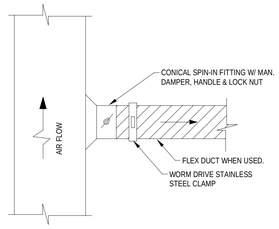
3 PIPE - INSULATED THRU WALL
NOT TO SCALE



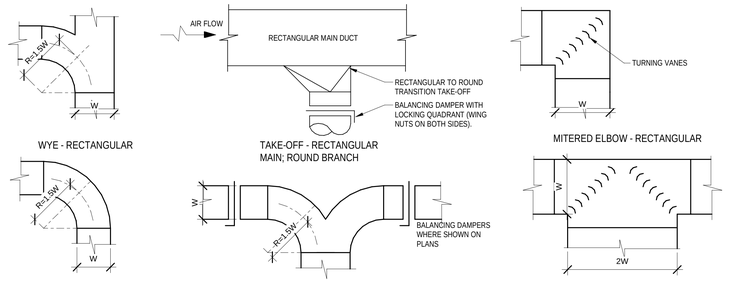
4 DUCT - CEILING SUPPLY DIFFUSER & RETURN GRILLE
NOT TO SCALE



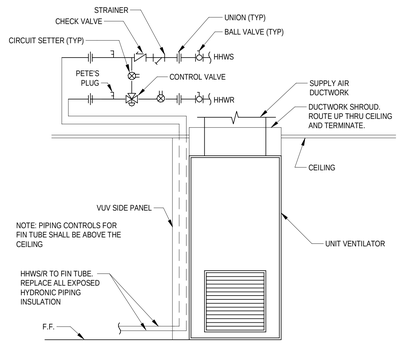
5 DUCT - FLEXIBLE DUCT CONNECTION
NOT TO SCALE



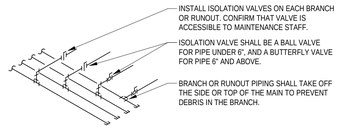
6 DUCT - ROUND BRANCH TAKE-OFF
NOT TO SCALE



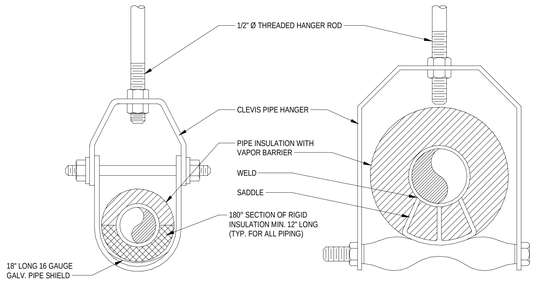
7 DUCT - RECTANGULAR FITTINGS
NOT TO SCALE

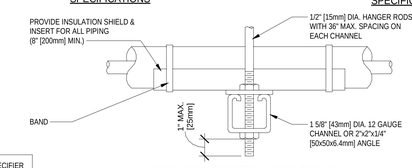


8 HYDRONICS - FIN TUBE CONTROL PIPING
NOT TO SCALE



9 PIPE - BRANCH OFF MAIN
NOT TO SCALE





NOTES: SEE SPECIFIER FOR DETAILED HANGER REQUIREMENTS

SIDE VIEW TRAPEZE HANGER FOR UP TO 1000 LB. [453KG] UNIFORM LOAD

MAXIMUM PIPE/TUBING SUPPORT SPACING																			
NOM. SIZE	IN. [mm]	THRU 3/4" THRU [20]	1 [25]	1 1/4 [32]	1 1/2 [40]	2 [50]	2 1/2 [65]	3 [75]	4 [100]	5 [125]	6 [150]	8 [200]	10 [250]	12 [300]	14 [350]	16 [400]	18 [450]	20 [500]	24 [600]
PIPE	FT. [mm]	7 [2100]	7 [2100]	7 [2100]	9 [2700]	10 [3000]	11 [3400]	12 [3700]	14 [4100]	16 [4900]	17 [5200]	19 [5900]	22 [6700]	23 [7000]	25 [7600]	27 [8200]	28 [8500]	30 [9100]	32 [9600]
TUBING	FT. [mm]	5 FT. [1500]	6 [1800]	7 [2100]	8 [2400]	9 [2700]	10 [3000]	12 [3700]	13 [4000]	14 [4100]	16 [4900]	- -	- -	- -	- -	- -	- -	- -	- -
NOTE: FOR TRAPEZE HANGER TAKE SPACING OF SMALLEST SIZE ON TRAPEZE.																			

10 PIPE - SUPPORT SPACING
NOT TO SCALE

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LANSING SCHOOL DISTRICT
AVERILL NEW TECH ELEMENTARY MECHANICAL IMPROVEMENTS
3301 AVERILL DR., LANSING, MI 48911

MECHANICAL DETAILS

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0117
DATE: 11-NOV-2022
SHEET
M-501

CONSTRUCTION DOCUMENTS

11/11/2022 12:24:24 PM
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DESIGNED BY: Designer
CHECKED BY: Checker APPROVED BY: Approver

PREPURCHASED PROVIDED BY OWNER, INSTALLATION BY CONTRACTOR

VERTICAL UNIT VENTILATOR SCHEDULE

GENERAL			ACCESSORIES				SUPPLY FAN				DX COOLING COIL				HYDRONIC HEATING									ELECTRICAL			NOTES
MARK	MANUFACT.	MODEL	10" REAR PLENUM	6" PIPE CHASE	20" TOP DUCT COVER	24" TOP PLENUM WITH DISCHARGE GRILLES	AIRFLOW (CFM)	OUTDOOR AIRFLOW (CFM)	ESP (IN-WG)	HP	TOTAL CAPACITY (MBH)	SENSIBLE CAPACITY (MBH)	EDB (°F)	EWB (°F)	CAPACITY (MBH)	EAT (°F)	LAT (°F)	FLOW (GPM)	WPD (FT-HD)	EWT (°F)	LWT (°F)	CONTROL VALVE	FLUID	VOLTAGE	PHASE	MCA	
VUV-103	CHANGEAIR	CAH-40-36-PA-VPS	1	1	1		1200	450	0.25	1/2	34	23.2	80	67	61	55	102	3.0	0.18	180	137	THREE-WAY	WATER	208	3	20.6	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
VUV-104	CHANGEAIR	CAH-40-36-PA-VPS	1	1	1		1200	450	0.25	1/2	34	23.2	80	67	61	55	102	3.0	0.18	180	137	THREE-WAY	WATER	208	3	20.6	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
VUV-107	CHANGEAIR	CAH-40-36-PA-VPS			1		1200	450	0.25	1/2	34	23.2	80	67	54	55	96	2.0	0.08	180	123	THREE-WAY	WATER	208	3	20.6	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
VUV-108	CHANGEAIR	CAH-40-36-PA-VPS			1		1200	450	0.25	1/2	34	23.2	80	67	54	55	96	2.0	0.08	180	123	THREE-WAY	WATER	208	3	20.6	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
VUV-109	CHANGEAIR	CAH-40-36-PA-VPS			1		1200	450	0.25	1/2	34	23.2	80	67	54	55	96	2.0	0.08	180	123	THREE-WAY	WATER	208	3	20.6	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
VUV-110	CHANGEAIR	CAH-40-36-PA-VPS		1	1		1200	450	0.25	1/2	34	23.2	80	67	54	55	96	2.0	0.08	180	123	THREE-WAY	WATER	208	3	20.6	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
VUV-111	CHANGEAIR	CAH-40-36-PA-VPS		1	1		1200	450	0.25	1/2	34	23.2	80	67	54	55	96	2.0	0.08	180	123	THREE-WAY	WATER	208	3	20.6	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
VUV-112	CHANGEAIR	CAH-40-36-PA-VPS			1		1200	450	0.25	1/2	34	23.2	80	67	54	55	96	2.0	0.08	180	123	THREE-WAY	WATER	208	3	20.6	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
VUV-117	CHANGEAIR	CAH-40-36-PA-VPS			1		1200	450	0.25	1/2	34	23.2	80	67	49	55	92	1.5	0.05	180	112	THREE-WAY	WATER	208	3	20.6	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
VUV-118	CHANGEAIR	CAH-40-36-PA-VPS			1		1200	450	0.25	1/2	34	23.2	80	67	49	55	92	1.5	0.05	180	112	THREE-WAY	WATER	208	3	20.6	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
VUV-119	CHANGEAIR	CAH-40-36-PA-VPS			1		1200	450	0.25	1/2	34	23.2	80	67	54	55	96	2.0	0.08	180	123	THREE-WAY	WATER	208	3	20.6	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
VUV-120	CHANGEAIR	CAH-40-36-PA-VPS			1		1200	450	0.25	1/2	34	23.2	80	67	54	55	96	2.0	0.08	180	123	THREE-WAY	WATER	208	3	20.6	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
VUV-121	CHANGEAIR	CAH-40-36-PA-VPS		1	1		1200	450	0.25	1/2	34	23.2	80	67	54	55	96	2.0	0.08	180	123	THREE-WAY	WATER	208	3	20.6	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
VUV-122	CHANGEAIR	CAH-40-36-PA-VPS			1		1200	450	0.25	1/2	34	23.2	80	67	54	55	96	2.0	0.08	180	123	THREE-WAY	WATER	208	3	20.6	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
VUV-123	CHANGEAIR	CAH-40-36-PA-VPS			1		1200	450	0.25	1/2	34	23.2	80	67	54	55	96	2.0	0.08	180	123	THREE-WAY	WATER	208	3	20.6	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
VUV-124	CHANGEAIR	CAH-40-36-PA-VPS		1	1		1200	450	0.25	1/2	34	23.2	80	67	54	55	96	2.0	0.08	180	123	THREE-WAY	WATER	208	3	20.6	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
VUV-130A	CHANGEAIR	CAH-40-36-PA-VPS		2		1	1200	450	0.25	1/2	34	23.2	80	67	54	55	96	2.0	0.08	180	123	THREE-WAY	WATER	208	3	20.6	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
VUV-130B	CHANGEAIR	CAH-40-36-PA-VPS		2		1	1200	450	0.25	1/2	34	23.2	80	67	54	55	96	2.0	0.08	180	123	THREE-WAY	WATER	208	3	20.6	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
VUV-130C	CHANGEAIR	CAH-40-36-PA-VPS		2		1	1200	450	0.25	1/2	34	23.2	80	67	54	55	96	2.0	0.08	180	123	THREE-WAY	WATER	208	3	20.6	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
VUV-130D	CHANGEAIR	CAH-40-36-PA-VPS		2		1	1200	450	0.25	1/2	34	23.2	80	67	54	55	96	2.0	0.08	180	123	THREE-WAY	WATER	208	3	20.6	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15

NOTES:
1. THE UNIT COLOR SHALL BE: SAND
2. PROVIDE WITH FACTORY STANDARD 4" LOUVER (COLOR: BRONZE) AND 12" DEEP WALL SLEEVE.
3. PROVIDED FACTORY RELIEF FAN BUILT IN TO UNIT.
4. PROVIDE FACTORY INSTALLED IQ SOUND PACKAGE.
5. PROVIDE INTEGRAL NON-FUSED DISCONNECT SWITCH.
6. PROVIDE INTERNAL FACTORY PIPING PACKAGE: 3 WAY MODULATING SPRING RETURN CONTROL VALVE, AN ISOLATION VALVE, A MANUAL BALANCING VALVE AND STRAINER.
7. PROVIDE REAR PLENUM, SIDE PIPE CHASE, TOP DUCT SHROUD AND TOP DISCHARGE PLENUM WITH DISCHARGE GRILLE AS INDICATED ON THE SCHEDULE. ALL CABINET ACCESSORIES SHALL MATCH COLOR OF UNIT.
8. UNIT SHALL HAVE 18 GAUGE STEEL CABINET PANELS.
9. PROVIDE HOT WATER SUPPLY AND RETURN PIPING STUBBED OUT THE TOP LEFT OF THE UNIT.
10. PROVIDE TWO STAGED SCROLL COMPRESSOR.
11. PROVIDE 2" PLEATED, MERV 13 FILTERS,
12. UNIT SHALL BE DDC READY WITH TERMINAL STRIP.
13. PROVIDE ECM SUPPLY FAN MOTOR AND CONDENSER MOTOR
14. PROVIDE INSULATED STAINLESS STEEL CONDENSATE PAN AND OVERFLOW SWITCH
15. UNIT SHALL HAVE A FREEZE PROTECTION.

DIFFUSER, REGISTER, AND GRILLE SCHEDULE

GENERAL			DESCRIPTION	FINISH	MATERIAL	NECK SIZE
MARK	MANUFACTURER	MODEL				
SD-1	PRICE	SCDA	24X24, ADJUSTABLE MULTI CONE LAY-IN DIFFUSER	WHITE	STEEL	SEE PLAN

TAB SCOPE

1. OBTAIN PRE-WORK HYDONIC FLOW TEST TO DETERMINE GPM OF EXISTING MECHANICAL EQUIPEMENT. UTILIZE THIS INFORMATION TO BALANCE THE SYSTEM ONCE NEW WORK IS COMPLETED.
2. PRIOR TO FULL TEST, FLUSH SYSTEM AND VERIFY ALL STRAINERS ARE FREE OF DEBRIS.
3. PERFORM FULL TEST AND BALANCE ON ALL NEW HVAC SYSTEMS BOTH AIRSIDE AND WATERSIDE.
4. REFER TO SPECIFICATION SECTION 230593 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

CONTROL SYSTEM DESCRIPTION

1. EXISTING CONTROLS EQUIPMENT TO REMAIN.
2. CONNECT EXISTING DDC BUILDING AUTOMATION SYSTEM (BAS) TO CONTROL ALL NEW VERTICAL UNIT VENTILATORS AND EXISTING NOTED FIN TUBE WITHIN THE BUILDING.
3. PROVIDE USER INTERFACE GRAPHICS AND PROGRAMMING TO REPRESENT THE NEW VERTICAL UNIT VENTILATORS. MODIFY NEWLY CONFIGURED FIN TUBE USER INTERFACE GRAPHICS AND PROGRAMMING ACCORDINGLY.

FIN TUBE HEATER SEQUENCE OF OPERATION

THE FIN TUBE HEATERS (PERIMETER HEATERS) SHALL BE CONTROLLED AS DESCRIBED WITHIN THE VUV SEQUENCE OF OPERATIONS.

VERTICAL UNIT VENTILATOR (VUV) - HHW COIL & SELF CONTAINTED DX COOLING - SEQUENCE OF OPERATION

A. GENERAL REQUIREMENTS FOR ALL VUVS:
1. PACKAGED UNIT WITH SELF-CONTAINED COMPRESSOR/CONDENSER AND DX COOLING COIL, HYDRONIC HEATING COIL, VARIABLE SPEED SUPPLY AND RELIEF FANS.
2. ALL SETPOINTS, DEADBANDS, AND TIME DELAYS DESCRIBED IN SEQUENCES SHALL BE ADJUSTABLE BY SYSTEM OPERATORS (CREATE REQUIRED VIRTUAL POINTS).
3. SPACE TEMPERATURE SETPOINTS SHALL BE AS FOLLOWS (UNLESS NOTED OTHERWISE). ALL SETPOINTS SHALL BE ADJUSTABLE (BY BAS OPERATOR ONLY).
   - OCCUPIED HEATING: 70° F
   - OCCUPIED COOLING: 75° F
   - UNOCCUPIED HEATING 60° F
   - UNOCCUPIED COOLING: 80° F
   - STANDBY/FLUSH HEATING: 67° F
   - STANDBY/FLUSH COOLING: 78° F
4. A 5° F DEADBAND BETWEEN ACTIVE HEATING AND COOLING SPACE TEMPERATURE SETPOINTS SHALL BE MAINTAIN TO PREVENT SHORT CYCLING SITUATIONS.
5. SPACE TEMPERATURE SENSOR (OR THERMOSTAT) SHALL INCLUDE A TEMPORARY UNCCUPIED-TO-OCCUPIED OVERRIDE BUTTON. DURATION OF TEMPORARY OVERRIDE SHALL BE LIMITED TO ONE-HOUR (ADJUSTABLE BY BAS OPERATOR ONLY).
6. SPACE TEMPERATURE SENSOR (OR THERMOSTAT) SHALL ALLOW FOR TEMPERATURE SETPOINT ADJUSTMENT OVERRIDE. SETPOINT OVERRIDE SHALL BE LIMITED TO +/- 3° F FROM PROGRAMMED SETPOINT WITH A DURATION LIMITED TO THE NEXT UNOCCUPIED MODE. WHEN VUV IS IN TEMPERATURE OVERRIDE, A GRAPHICAL ICON SHALL BE ACTIVATED AT THE BAS.

B. UNOCCUPIED MODE:
1. WHEN THE BAS OCCUPANCY SCHEDULE DETERMINES THAT THE BUILDING, ZONE, AND SPACE IS TO BE UNOCCUPIED, THE UNOCCUPIED HEATING/COOLING SETPOINTS SHALL BE ACTIVE. THE VUV CONTROLLER SHALL DEENERGIZE THE SUPPLY FAN, CLOSE THE OUTSIDE AIR DAMPER AND HEATING COIL VALVE, AND DISABLE THE RELIEF FAN (IF APPLICABLE).
2. IF THE SPACE TEMPERATURE RISES ABOVE THE UNOCCUPIED COOLING SETPOINT, THE DX COOLING COIL SHALL BE ENABLED AND THE SUPPLY AIR FAN SHALL MODULATE UP TO MAXIMUM DESIGN AIRFLOW TO MAINTAIN A DISCHARGE AIR TEMPERATURE OF 55° F. ONCE THE SPACE TEMPERATURE DROPS SUFFICIENTLY BELOW THE UNOCCUPIED COOLING SETPOINT, THE DX COOLING COIL SHALL BE DISABLED AND THE SUPPLY FAN SHALL BE DEENERGIZED.
   - THE ECONOMIZER MODE SHALL OPERATE THE SAME DURING BOTH UNOCCUPIED AND OCCUPIED MODES.
3. IF THE SPACE TEMPERATURE DROPS BELOW THE UNOCCUPIED HEATING SETPOINT, THE VUV CONTROLLER SHALL FIRST MODULATE THE PERIMETER HEATING VALVE (IF APPLICABLE) TO MAINTAIN THE SPACE TEMPERATURE. IF THE UNOCCUPIED TEMPERATURE SETPOINT CANNOT BE ACHIEVED WITHIN 30 MINUTES (ADJUSTABLE), OR IF THE SPACE TEMPERATURE CONTINUES TO DROP, THE SUPPLY FAN SHALL MODULATE TO 50% DESIGN AIRFLOW AND THE HEATING COIL VALVE SHALL MODULATE TO HEAT THE SPACE. ONCE THE SPACE TEMPERATURE RISES SUFFICIENTLY ABOVE THE UNOCCUPIED HEATING SETPOINT, THE HEATING COIL VALVE SHALL CLOSE, THE SUPPLY FAN SHALL BE DEENERGIZED, AND THE PERIMETER HEATING VALVE (IF APPLICABLE) SHALL MODULATE CLOSED.
4. IF THE TEMPORARY UNOCCUPIED-TO-OCCUPIED OVERRIDE BUTTON ON THE SPACE TEMPERATURE SENSOR (OR THERMOSTAT) IS PRESSED, THE VUV SHALL OPERATE IN THE OCCUPIED MODE FOR A LIMITED DURATION.

C. OCCUPIED MODE:
1. WHEN THE BAS OCCUPANCY SCHEDULE DETERMINES THAT THE BUILDING, ZONE, AND SPACE IS TO BE OCCUPIED, THE OCCUPIED HEATING/COOLING SETPOINTS SHALL BE ACTIVE. THE VUV CONTROLLER SHALL MODULATE THE SUPPLY AIR FAN TO 50% DESIGN AIRFLOW (ADJUSTABLE) AND OPEN THE OUTSIDE AIR DAMPER TO MINIMUM POSITION (10% OF MAXIMUM DESIGN AIRFLOW). RELIEF FAN (IF APPLICABLE) SHALL REMAIN OFF.
   - THE RELIEF FAN SHALL MODULATE TO A MINIMUM SPEED (ADJUSTABLE) TO ENSURE AN APPROPRIATE AMOUNT OF RELIEF AIR IS EXPELLED FROM THE SPACE.
2. IF THE SPACE TEMPERATURE RISES ABOVE THE OCCUPIED COOLING SETPOINT, THE DX COOLING COIL SHALL BE ENABLED AND THE SUPPLY AIR FAN SHALL MODULATE UP TO MAXIMUM DESIGN AIRFLOW WHILE MAINTAINING A DISCHARGE AIR TEMPERATURE OF 55° F. ONCE THE SPACE TEMPERATURE DROPS SUFFICIENTLY BELOW THE OCCUPIED COOLING SETPOINT, THE DX COOLING COIL SHALL BE DISABLED AND THE SUPPLY FAN SHALL MODULATE TO 50% DESIGN AIRFLOW.
3. IF THE SPACE TEMPERATURE DROPS BELOW THE OCCUPIED HEATING SETPOINT, THE VUV CONTROLLER SHALL MODULATE THE HEATING COIL VALVE TO MAINTAIN THE SPACE TEMPERATURE SETPOINT. ONCE THE SPACE TEMPERATURE SETPOINT IS REACHED, THE HEATING COIL VALVE SHALL MODULATE TO MAINTAIN A MINIMUM DISCHARGE AIR TEMPERATURE OF 70° F (ADJUSTABLE). ONCE THE SPACE TEMPERATURE RISES SUFFICIENTLY ABOVE THE OCCUPIED HEATING SETPOINT, THE HEATING COIL VALVE SHALL MODULATE CLOSED.
   - IF THE DISCHARGE AIR TEMPERATURE EXCEEDS A MAXIMUM OF 95° F (ADJUSTABLE) AND THE SPACE TEMPERATURE REMAINS BELOW SETPOINT, THE VUV CONTROLLER SHALL GRADUALLY INCREASE THE SUPPLY AIR FAN IN 10% INCREMENTS UNTIL THE SPACE SETPOINT IS ACHIEVED. ONCE THE SPACE TEMPERATURE SETPOINT IS ACHIEVED, THE SUPPLY FAN SHALL MODULATE TO 50% DESIGN AIRFLOW.
   - DURING THE OCCUPIED MODE, THE PERIMETER HEATING VALVE (IF APPLICABLE) SHALL MODULATE IN SEQUENCE WITH THE HEATING COIL VALVE (SAME POSITION).

D. ECONOMIZER MODE (FREE COOLING):
1. WHEN THE OUTSIDE AIR TEMPERATURE IS LESS THAN 65°F (ADJUSTABLE) AND THE OUTSIDE AIR ENTHALPY IS LESS THAN THE SPACE ENTHALPY, THE OUTSIDE AIR DAMPER, RETURN AIR DAMPER, AND SUPPLY FAN SPEED SHALL MODULATE IN SEQUENCE TO MAINTAIN THE SPACE COOLING SETPOINT TEMPERATURE. THE DISCHARGE AIR TEMPERATURE SHALL NOT FALL BELOW 50° F DURING ECONOMIZER MODE.
   - THE RELIEF FAN SHALL MODULATE UP TO A PRE-DETERMINED MAXIMUM SPEED (NOT TO EXCEED THE MAXIMUM SUPPLY AIRFLOW RATE) TO ENSURE SPACE IS NOT OVER PRESSURIZED DURING ECONOMIZER MODE.
2. THE DX COOLING COIL SHALL REMAIN DISABLED UNTIL THE OUTSIDE AIR DAMPER REACHES THE 100% OPEN POSITION AND THE SPACE TEMPERATURE IS STILL ABOVE SETPOINT.

E. STANDBY MODE (WITH OCCUPANCY SENSOR):
1. WHEN THE BAS OCCUPANCY SCHEDULE DETERMINES THAT THE BUILDING, ZONE, AND SPACE IS TO BE OCCUPIED, HOWEVER THE OCCUPANCY SENSOR INDICATES (AFTER A TIME DELAY) THAT THERE ARE NO PEOPLE PRESENT IN THE SPACE, THE OUTSIDE AIR DAMPER SHALL CLOSE AND THE SUPPLY FAN SHALL MODULATE TO 50% DESIGN AIRFLOW (ADJUSTABLE). THE STANDBY HEATING/COOLING SETPOINTS SHALL BE ACTIVE. HEATING AND COOLING SEQUENCES SHALL BE THE SAME FOR BOTH OCCUPIED AND STANDBY MODES.
2. ONCE THE OCCUPANCY SENSOR DETECTS THAT A PERSON HAS ENTERED THE SPACE, AND THE BAS DETERMINES THAT THE SPACE IS STILL SCHEDULED TO BE OCCUPIED, THE VUV CONTROLLER SHALL RETURN TO OCCUPIED MODE.

F. DEMAND CONTROL VENTILATION MODE (WITH CO2 MONITORING):
1. EACH VUV CONTROLLER SHALL INCLUDE THE ABILITY TO OVERRIDE THE OUTSIDE AIR DAMPER POSITION WITH THE CO2 SENSOR, AND CORRESPONDING LOW/HIGH CO2 SETPOINTS, IN CONJUNCTION WITH THE NORMAL TEMPERATURE CONTROL.
2. DURING THE OCCUPIED MODE ONLY, THE VUV CONTROLLER SHALL MONITOR THE SPACE CO2 SENSOR. WHEN THE CO2 CONCENTRATION IN THE SPACE EXCEEDS 900 PPM (ADJUSTABLE), THE OUTSIDE AIR DAMPER SHALL MODULATE OPEN IN 5% INCREMENTS. ONCE THE CO2 CONCENTRATION DROPS BELOW 700 PPM (ADJUSTABLE), THE VUV CONTROLLER SHALL MODULATE THE OUTSIDE AIR DAMPER BACK TO ITS PROGRAMMED MINIMUM POSITION OF 10% OPEN (ADJUSTABLE).
   - THE RELIEF FAN SHALL MODULATE UP TO A PRE-DETERMINED MAXIMUM SPEED (NOT TO EXCEED THE MAXIMUM SUPPLY AIRFLOW RATE) TO ENSURE SPACE IS NOT OVER PRESSURIZED DURING DCV MODE.
   - VUV CONTROLLER SHALL PROHIBIT FURTHER INCREASES OF THE OUTSIDE AIR DAMPER POSITION IF THE SPACE TEMPERATURE SETPOINTS CANNOT BE MAINTAINED.
   - IF THE VUV CONTINUES TO OPERATE IN VENTILATION MODE FOR LONGER THAN 2 HOURS (ADJUSTABLE), A VENTILATION ALARM NOTIFICATION SHALL BE GENERATED AND THE VUV CONTROLLER SHALL MODULATE THE OUTSIDE AIR DAMPER BACK TO ITS PROGRAMMED MINIMUM POSITION.
3. WHEN ANY VUV IS IN DEMAND CONTROLLED VENTILATION MODE, A GRAPHICAL ICON SHALL BE ACTIVATED AT THE BAS.

G. PRE-OCCUPANCY PURGE MODE:
1. 30 MINUTES PRIOR TO A SCHEDULED OCCUPIED PERIOD, THE VUV CONTROLLER SHALL MODULATE THE SUPPLY FAN TO 100% DESIGN AIRFLOW AND THE OUTSIDE AIR, RETURN AIR, AND RELIEF AIR DAMPERS SHALL MODULATE TO PROVIDE THE MINIMUM OUTSIDE AIR CFM (BASED ON MAXIMUM OCCUPANT LOADING OF THE SPACE). ONCE THE PURGE MODE COMPLETES ITS 30 MINUTE CYCLE THE VUV SHALL SWITCH TO OCCUPIED MODE.
2. MORNING WARM-UP: IF THE SPACE TEMPERATURE IS BELOW THE OCCUPIED HEATING SETPOINT, THE VUV CONTROLLER SHALL MODULATE THE HEATING COIL VALVE TO MAINTAIN A 95° F DISCHARGE AIR TEMPERATURE (ADJUSTABLE) UNTIL THE SPACE TEMPERATURE SETPOINT IS REACHED.
3. MORNING COOL-DOWN: IF THE SPACE TEMPERATURE IS ABOVE THE OCCUPIED COOLING SETPOINT, THE VUV CONTROLLER SHALL ENABLE THE DX COOLING (OR ECONOMIZER) UNTIL THE SPACE TEMPERATURE SETPOINT IS REACHED.

H. POST-OCCUPANCY FLUSH MODE:
1. AT THE END OF EACH SCHEDULED OCCUPIED PERIOD, THE VUV CONTROLLER SHALL MODULATE THE SUPPLY FAN TO 100% DESIGN AIRFLOW AND THE OUTSIDE AIR, RETURN AIR, AND RELIEF AIR DAMPERS SHALL MODULATE TO PROVIDE THE MINIMUM OUTSIDE AIR CFM (BASED ON MAXIMUM OCCUPANT LOADING OF THE SPACE). ONCE THE FLUSH MODE COMPLETES ITS 30 MINUTE CYCLE THE VUV SHALL SWITCH TO UNOCCUPIED MODE.
2. THE VUV CONTROLLER SHALL MODULATE THE HEATING COIL VALVE, DX COOLING (OR ECONOMIZER) TO MAINTAIN THE SPACE FLUSH TEMPERATURE SETPOINTS.

I. FREEZE PROTECTION & CONDENSATE OVERFLOW:
1. IF THE DISCHARGE AIR TEMPERTURE DROPS BELOW 45° F FOR LONGER THAN 5 MINUTES (ADJUSTABLE), A LOW TEMPERATURE NOTIFICATION SHALL BE GENERATED AT THE BAS.
2. IF THE HEATING COIL FREEZESTAT DETECTS A TEMPERATURE BELOW 38° F, A FREEZE PROTECTION ALARM WILL BE GENERATED AT THE BAS, AND THE FOLLOWING ACTIONS SHALL OCCUR:
3. OUTSIDE AIR DAMPER SHALL CLOSE
4. SUPPLY FAN SHALL STOP (AND RELIEF FAN SHALL STOP IF APPLICABLE)
5. HEATING COIL CONTROL VALVE SHALL MODULATE TO 100% OPEN POSITION
3. IF THE CONDESNATE OVERFLOW SWITCH DETECTS THAT THE PRIMARY CONDENSATE DRAIN HAS BEEN PLUGGED, THE DX COOLING MODE SHALL BE DISABLED AND A CONDESNATE OVERFLOW NOTIFICATION WILL BE GENERATED AT THE BAS.:

[END OF SEQUENCE]

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AVERILL NEW TECH ELEMENTARY MECHANICAL IMPROVEMENTS
3201 AVERILL DR., LANSING, MI 48911

MECHANICAL SCHEDULES

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0117
DATE: 11-NOV-2022
SHEET
M-601

CONSTRUCTION DOCUMENTS

WE RECYCLE
THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID
BLACK
WHITE

11/11/2022 12:24:27 PM
C:\Users\john.petty\Documents\220117_M_jack.pettyTGZEQ.rvt
DESIGNED BY: Designer
CHECKED BY: Checker APPROVED BY: Approver

WE RECYCLE
THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID
BLACK
WHITE

ELECTRICAL ABBREVIATIONS

1P	SINGLE POLE
1PH	SINGLE PHASE
2P	TWO POLE
3P	THREE POLE
3PH	THREE PHASE
©	COPYRIGHT
°	DEGREES
Δ	DELTA
Φ	PHASE
∟	ANGLE
A	AMP
AAP	ALARM ANNUNCIATOR PANEL
AC	AIRCRAFT CABLE
AC	ABOVE COUNTER
ACU	AIR CONDITIONING UNIT
AF	AMP FUSE
AFC	AVAILABLE FAULT CURRENT
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
AHJ	AUTHORITY HAVING JURISDICTION
AHU	AIR HANDLING UNIT
ASC	AMPS SHORT CIRCUIT
AT	AMPERE TRIP
ATS	AUTOMATIC TRANSFER SWITCH
AUTO	AUTOMATIC
AV	AUDIO VISUAL
AWG	AMERICAN WIRE GAUGE
BC	BARE COPPER
BD	BOARD
BFF	BELOW FINISHED FLOOR
BKR	BREAKER
BLDG	BUILDING
BMS	BUILDING MANAGEMENT SYSTEM
BOD	BOTTOM OF DEVICE
BOF	BOTTOM OF FIXTURE
BYP	BYPASS
C	CONDUIT
CCR	CONTROL CONTACT
CCTV	CLOSED CIRCUIT TELEVISION
CF	CONTRACTOR FURNISHED
CF/CI	CONTRACTOR FURNISHED / CONTRACTOR INSTALLED
CF/OI	CONTRACTOR FURNISHED / OWNER INSTALLED
CHH	COMMUNICATIONS HANDHOLE
CKT	CIRCUIT
CKT BKR	CIRCUIT BREAKER
CLF	CURRENT LIMITING FUSE
CLG	CEILING
CMH	COMMUNICATIONS MANHOLE
COAX	COAX CABLE
COMM	COMMUNICATION
CP	CONTROL PANEL
CRI	COLOR RENDERING INDEX
CT	CURRENT TRANSFORMER
CTV	CABLE TV
CU	COPPER
D	DATA
DB	DIRECT BURIAL
DCP	DIMMER CONTROL PANEL
DEG C	DEGREES CELSIUS
DEG F	DEGREES FAHRENHEIT
DEMO	DEMOLITION
DISC	DISCONNECT

ELECTRICAL ABBREVIATIONS

DIST	DISTRIBUTION
DMR	DIMMER
DN	DOWN
DPDT	DOUBLE POLE, DOUBLE THROW
DPST	DOUBLE POLE, SINGLE THROW
(E)	EXISTING
EC	ELECTRICAL CONTRACTOR
EG	EQUIPMENT GROUND
EHH	ELECTRICAL HANDHOLE
ELEC	ELECTRIC OR ELECTRICAL
ELEV	ELEVATOR
EM	EMERGENCY
EMH	ELECTRICAL MANHOLE
EMI	ELECTROMAGNETIC INTERFERENCE
EMT	ELECTRICAL METALLIC TUBING
ENCL	ENCLOSURE
EPO	EMERGENCY POWER OFF
ETR	EXISTING TO REMAIN
EWC	ELECTRIC WATER COOLER
EWH	ELECTRIC WATER HEATER
EX	EXISTING
EXIST	EXISTING
EXP	EXPLOSION PROOF
EXT	EXTERNAL
(F)	FIELD LOCATED
FA	FIRE ALARM
FAAP	FIRE ALARM ANNUNCIATOR PANEL
FACP	FIRE ALARM CONTROL PANEL
FDR	FEEDER
FF	FINISH FLOOR
FIXT	FIXTURE
FLA	FULL LOAD AMPS
FLEX	FLEXIBLE METALLIC CONDUIT
FLUOR	FLUORESCENT
FP	FIRE PROTECTION
FT	FEET OR FOOT
FVNR	FULL VOLTAGE NON-REVERSING
FVR	FULL VOLTAGE REVERSING
GC	GENERAL CONTRACTOR
GDP	GENERATOR DISTRIBUTION PANEL
GEN	GENERATOR
GFCI	GROUND FAULT CIRCUIT INTERRUPTER
GFI	GROUND FAULT CIRCUIT INTERRUPTER
GND	GROUND
HH	HANDHOLE
HID	HIGH INTENSITY DISCHARGE
HOA	HAND-OFF-AUTOMATIC
HP	HORSE POWER
HT	HEIGHT
HZ	HERTZ
IESNA	ILLUMINATION ENGINEERING SOCIETY OF NORTH AMERICA
IMC	INTERMEDIATE METAL CONDUIT
IR	INFRARED
IS	INSTANT START (BALLAST)
IWH	INSTANTANEOUS WATER HEATER
JB	JUNCTION BOX
JXN	JUNCTION BOX
KV	KILOVOLT
KVA	KILOVOLT AMPERE
KVAR	KILOVOLT AMPERE REACTIVE
KW	KILOWATT
LC	LIGHTING CONTACTOR

ELECTRICAL ABBREVIATIONS

LED	LIGHT EMITTING DIODE
LF	LINEAR FEET
LGR	BMS CONTROLLER PANEL
LM	LUMEN
LPS	LOW PRESSURE SODIUM
LRA	LOCKED ROTOR AMPS
LT	LIGHT
LTG	LIGHTING
LTG PNL	LIGHTING PANEL
LTNG	LIGHTNING
LV	LOW VOLTAGE
MATV	MASTER ANTENNA TELEVISION SYSTEM
MAX	MAXIMUM
MC	METAL-CLAD
MCA	MINIMUM CIRCUIT AMPS
MCB	MAIN CIRCUIT BREAKER
MCC	MOTOR CONTROL CENTER
MCP	MIXER CONTROL PANEL
MDP	MAIN DISTRIBUTION PANEL
MECH	MECHANICAL
MFR	MANUFACTURER
MH	MANHOLE
MICRO	MICROWAVE
MIN	MINIMUM
MLO	MAIN LUGS ONLY
MOCP	MAXIMUM OVERCURRENT PROTECTION
MSB	MAIN SWITCH BOARD
MT	MOUNT
MTD	MOUNTED
MTG	MOUNTING
MTR	MOTOR
MTS	MANUAL TRANSFER SWITCH
MV	MEDIUM VOLTAGE
N	NEUTRAL
NA	NOT APPLICABLE
NC	NORMALLY CLOSED
NEC	NATIONAL ELECTRIC CODE
NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NIC	NOT IN CONTRACT
NL	NIGHT LIGHT
NO	NORMALLY OPEN
NTS	NOT TO SCALE
OC	ON CENTER
OCP	ODOR CONTROL PANEL
OD	OUTSIDE DIAMETER
OL	OVERLOADS THERMAL
OLC	OUTDOOR LIGHTING CONTACTOR
OS	OCCUPANCY SENSOR
P	POLE OR PUMP
PA	PUBLIC ADDRESS
PB	PUSHBUTTON OR PULL BOX
PBPU	PREFABRICATED BEDSIDE PATIENT UNIT
PC	PHOTO-SWITCH
PCB	POLYCHLORINATED BIPHENYL
PEC	PHOTOELECTRIC CELL
PED	PEDESTAL
PEND	PENDANT
PF	POWER FACTOR
PFRE	POWER FAILURE RELAY ENCLOSURE
PH	PHASE
PLC	PROGRAMMABLE LOGIC CONTROLLER

ELECTRICAL ABBREVIATIONS

PNL	PANEL
PTT	PUSH-TO-TEST
PVC	POLYVINYL CHLORIDE (PLASTIC)
PWR	POWER
R	RELAY
RCP	REFLECTED CEILING PLAN
REC	RECESSED
RECEPT	RECEPTACLE
REQD	REQUIRED
RGS	RIGID GALVANIZED STEEL
RM	ROOM
RMC	RIGID METAL CONDUIT
SASW	SAFETY SWITCH
SCC	SHORT CIRCUIT CAPACITY
SD	SMOKE DETECTOR
SES	SERVICE ENTRANCE SECTION
SF	SQUARE FOOT (FEET)
SH	SHIELDED
SHT	SHEET
SI	INTERNATIONAL SYSTEM OF UNITS
SPD	SURGE PROTECTIVE DEVICE
SPEC	SPECIFICATION
SPST	SINGLE POLE, SINGLE THROW
SSRV	SOLID STATE REDUCED VOLTAGE
SURF	SURFACE
SW	SWITCH
SWBD	SWITCHBOARD
SWD	SWITCHING DUTY
SWGR	SWITCHGEAR
SZ	SIZE
TB	TERMINAL BOX
TC	TIME CLOCK
TEL	TELEPHONE
TP	TWISTED PAIR
TPS	TWISTED PAIR SHIELDED
TTB	TELEPHONE TERMINAL BOARD
TV	TELEVISION
TYP	TYPICAL
UFD	UNDERFLOOR DUCT
UGND	UNDERGROUND
UL	UNDERWRITERS LABORATORY
UNV	UNIVERSAL VOLTAGE DRIVER
UON	UNLESS OTHERWISE NOTED
UPS	UNINTERRUPTIBLE POWER SUPPLY
UTIL	UTILITY
V	VOLT
VA	VOLT AMPERE
VFC	VARIABLE FREQUENCY CONTROLLER
VFD	VARIABLE FREQUENCY DRIVE
VM	VOLT METER
VOLT	VOLTAGE
VSC-X	VENTILATION CONTROL STATION, TYPE X
W	WATT
W	WIRE
W/	WITH
WH	WATER HEATER
WP	WEATHERPROOF
XFAF	XX AMPERE FUSE
XFAS	XX AMPERE SWITCH
XFER	TRANSFER

EQUIPMENT/WIRING

C - CONTRACTOR
O - OWNER
V - OWNER'S VENDOR

BACKBOX & RACEWAY BY	FURNISHED BY	INSTALLED BY	WIRED BY	SYMBOL	DESCRIPTION	TYP. HT AFF
C	C	C	C		SWITCH, SINGLE POLE	BOD 44"
C	C	C	C		SWITCH, PRESET TIMER SWITCH	BOD 44"
C	C	C	C		SWITCH, SINGLE POLE FUSED - SIZE PER EQUIPMENT, MOUNT TO EQUIPMENT OR	BOD 44"
C	C	C	C		SWITCH, MANUAL MOTOR STARTER - SIZE PER EQUIPMENT, MOUNT TO EQUIPMENT OR	BOD 44"
C	C	C	C		PUSH BUTTON OPERATOR OR CONTROL STATION	TOD 48"
C	C	C	C		3 BUTTON OPERATOR	
C	C	C	C		ENCLOSED CIRCUIT BREAKER	TOD 72"
C	C	C	C		DISCONNECT, NON-FUSED	TOD 72"
C	C	C	C		DISCONNECT, FUSED	TOD 72"
C	C	C	C		STARTER	TOD 72"
C	C	C	C		COMBINATION STARTER/DISCONNECT, NON-FUSED	TOD 72"
C	C	C	C		COMBINATION STARTER/DISCONNECT, FUSED	TOD 72"
C	C	C	C		VARIABLE FREQUENCY DRIVE	TOD 72"
C	C	C	C		MOTOR, SINGLE PHASE	
C	C	C	C		MOTOR, THREE PHASE	
C	C	C	C	GBB	GROUNDING BUS BAR	18"
C	C	C	C		ELECTRICAL PANEL, SURFACE OR RECESSED	TOD 72"
C	C	C	C		DATA RACK	
C	C	C	C		ELECTRICAL CONDUIT	
C	C	C	C		ELECTRICAL CONDUIT, UNDERGROUND	
C	C	C	C		ELECTRICAL CONDUIT, VERTICAL RUN	

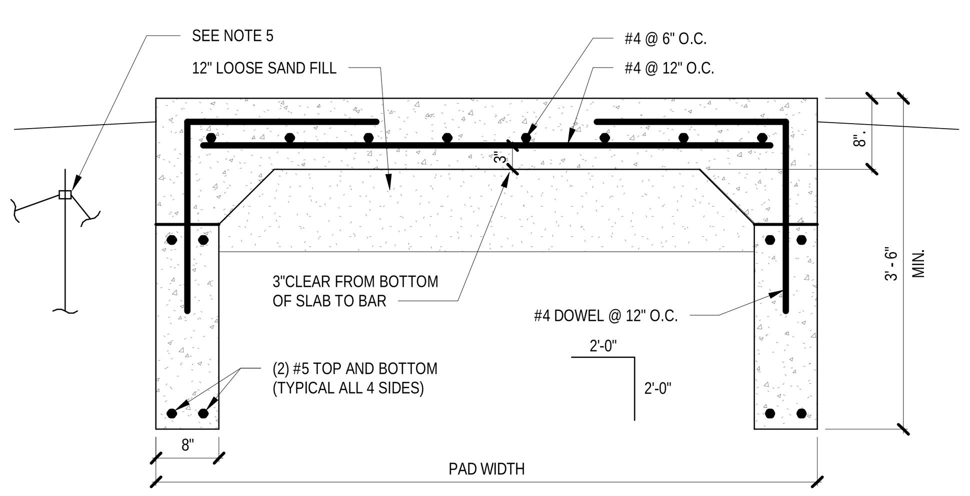
FIRE ALARM

C - CONTRACTOR
O - OWNER
V - OWNER'S VENDOR

BACKBOX & RACEWAY BY	FURNISHED BY	INSTALLED BY	WIRED BY	SYMBOL	DESCRIPTION	TYP. HT AFF
C	C	C	C	F	MANUAL PULL STATION	BOD 44"
C	C	C	C	V	VISUAL NOTIFICATION DEVICE, WALL MOUNTED	BOD 96"
C	C	C	C		AUDIO NOTIFICATION DEVICE, WALL MOUNTED	BOD 96"
C	C	C	C		AUDIO/VISUAL NOTIFICATION DEVICE, WALL MOUNTED	BOD 96"
C	C	C	C	V	VISUAL NOTIFICATION DEVICE, CEILING MOUNTED	
C	C	C	C	A	AUDIO NOTIFICATION DEVICE, CEILING MOUNTED	
C	C	C	C	AV	AUDIO/VISUAL NOTIFICATION DEVICE, CEILING MOUNTED	
C	C	C	C	SD	SMOKE DETECTOR, CEILING MOUNTED	
C	C	C	C	HD	HEAT DETECTOR, CEILING MOUNTED	
C	C	C	C	DD	DUCT DETECTOR	
C	C	C	C	DH	MAGNETIC DOOR HOLD DEVICE, WALL MOUNTED	84"
C	C	C	C	FS	FLOW SWITCH DEVICE	
C	C	C	C	TS	TAMPER SWITCH DEVICE	
C	C	C	C	FACP	FIRE ALARM CONTROL PANEL	TOD 72"
C	C	C	C	FAAP	FIRE ALARM ANNUNCIATOR PANEL	TOD 72"
C	C	C	C	FAPS	FIRE ALARM POWER SUPPLY (NAC)	TOD 72"

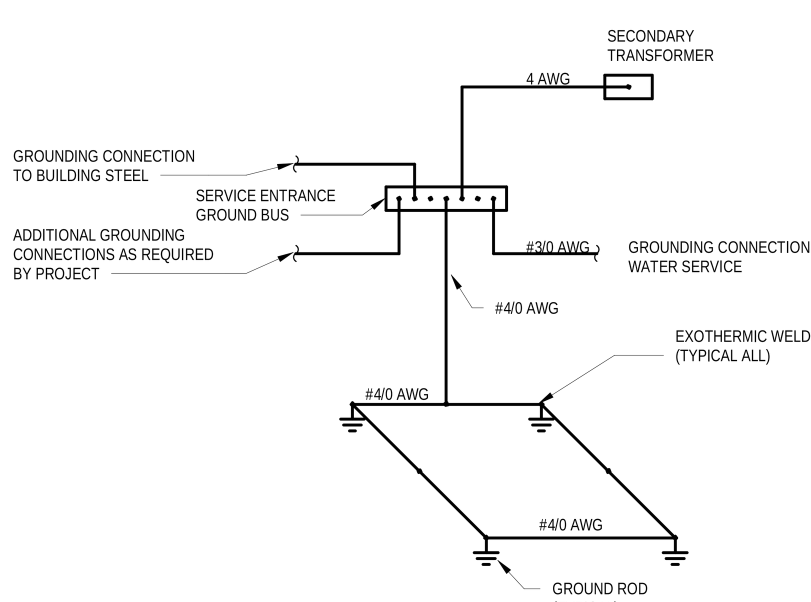
GENERAL NOTES

A. ALL WORK SHALL BE COMPLETED IN ACCORDANCE WITH THE 2017 EDITION OF THE NATIONAL ELECTRICAL CODE (NEC) AND ALL STATE AND LOCAL CODES.
B. AREAS ADJACENT TO THE PROJECT WORK AREA WITHIN THE FACILITY ARE TO REMAIN OPERATIONAL DURING NORMAL HOURS OF FACILITY OPERATION. COORDINATE ALL REQUIRED SYSTEM SHUTDOWNS WITH THE OWNER TO MINIMIZE DISRUPTION OF STAFF WITHIN THE FACILITY.
C. WORK MAY BE REQUIRED TO BE PERFORMED DURING OFF HOURS TO AVOID INTERFERING WITH THE OPERATION OF THE FACILITY. SEE PHASING OR CONSTRUCTION SEQUENCING INFORMATION ON THE DRAWINGS AND/OR IN THE SPECIFICATIONS.
D. WHERE ELECTRICAL DEMOLITION WORK IS REQUIRED, IT SHALL INCLUDE REMOVAL OF ELECTRICAL MATERIALS AND EQUIPMENT. INCLUDE REMOVAL OF SERVICE, FEEDER AND BRANCH CIRCUIT CONDUCTORS, EXPOSED CONDUIT, HANGERS, ETC. BACK TO SOURCE. CONDUIT CONCEALED IN BUILDING CONSTRUCTION SHALL BE CUT OFF FLUSH WITH SURFACE AND PLUGGED WITH NON-SHRINK GROUT. UNDERGROUND CONDUIT SHALL BE CUT OFF 24 INCHES BELOW GRADE AND PLUGGED.
E. COORDINATE THE INSTALLATION OF ALL EQUIPMENT REQUIRING ELECTRICAL CONNECTIONS WITH ARCHITECTURAL AND MECHANICAL PLANS, SPECIFICATIONS AND EQUIPMENT DRAWINGS. PROVIDE ALL NECESSARY EQUIPMENT POWER AND CONTROL CONNECTIONS NOT PROVIDED BY OTHERS WHETHER INDICATED ON THE DRAWINGS OR NOT.
F. SEAL ALL WALL AND FLOOR PENETRATIONS TO MAINTAIN RATING.
G. BACK-TO-BACK OR THROUGH THE WALL BOXES SHALL NOT BE USED.
H. ALL CONDUITS RUN IN CONCRETE FLOOR SLABS SHALL BE SPACED A MINIMUM OF ONE CONDUIT DIAMETER APART EXCEPT WHERE THEY EXIT THE SLAB TO RISE TO A PANEL.
I. INSTALL AN INSULATED, GREEN, GROUNDING CONDUCTOR IN ALL FEEDER AND BRANCH CIRCUIT RACEWAYS.
J. SPLICE CABLES OR CONDUCTORS IN OUTLET BOXES, DEVICE BOXES, PULL BOXES, JUNCTION BOXES, MANHOLES OR HANDHOLES. DO NOT SPLICE CABLES OR CONDUCTORS IN CONDUIT BODIES.
K. BRANCH CIRCUITS FROM CIRCUIT BREAKER TYPE DISTRIBUTION EQUIPMENT WHICH SUPPLY MOTOR LOADS THAT ARE LESS THAN 6.0 AMP SHALL BE PROTECTED BY A 15 AMP CIRCUIT BREAKER.
L. FINAL CONNECTIONS TO ITEMS SUBJECT TO VIBRATION SHALL BE MADE WITH FLEXIBLE METAL CONDUIT OR LIQUID TIGHT FLEXIBLE METAL CONDUIT. FLEXIBLE METAL CONDUIT AND LIQUID TIGHT FLEXIBLE METAL CONDUIT SHALL NOT BE USED AS A GROUNDING CONDUCTOR. PROVIDE A SEPARATE GREEN GROUNDING CONDUCTOR.
M. ALL BELOW GRADE LOCATIONS WITHIN BUILDINGS ARE DAMP LOCATIONS UNLESS OTHERWISE NOTED.
N. 480VAC POWER WIRING TO PROCESS EQUIPMENT SHALL BE RUN IN INDIVIDUAL RACEWAYS. COMBINING 480VAC WIRING FOR MORE THAN ONE EQUIPMENT ITEM IN A SINGLE RACEWAY OR IN PULLBOXES WILL NOT BE PERMITTED.
O. 120VAC CONTROL WIRING ASSOCIATED WITH MOTOR CONTROL CIRCUITS MAY BE RUN IN THE SAME RACEWAY WITH MOTOR POWER WIRING FOR CONSTANT SPEED MOTORS LESS THAN 30HP. FOR MOTORS 30HP AND GREATER OR FOR MOTORS POWERED FROM VARIABLE FREQUENCY CONTROLLERS, SEPARATE RACEWAYS SHALL BE USED FOR POWER AND CONTROL CONDUCTORS.
P. WITHIN ANY ROOM OR AREA, 120VAC CONTROL WIRING TO THE SAME DESTINATION MAY BE RUN IN THE SAME RACEWAY.
Q. 120/208VAC CIRCUIT WIRING FOR ANY ROOM OR AREA MAY BE GROUPED INTO RACEWAYS AS REQUIRED UNLESS SEPARATE RACEWAYS ARE REQUIRED BY THE NEC. COMPLY WITH NEC REQUIREMENTS FOR CONDUCTOR DERATING.
R. PROVIDE 4-INCH CONCRETE HOUSEKEEPING PADS FOR ALL FLOOR MOUNTED ELECTRICAL EQUIPMENT. SIZE PADS 3 INCHES LARGER THAN EQUIPMENT AND CHAMFER UPPER CORNERS.
S. CONDUIT PENETRATIONS OF FLOORS, LOWER LEVEL EXTERIOR WALLS OR WETWELL WALLS SHALL BE SLEEVED AND SEALED WITH LINKSEAL. SEE DETAILS ON MECHANICAL DRAWINGS.
T. CONDUIT RUNS IS FINISHED AREAS WITH EXPOSED CEILINGS ARE TO BE SUBMITTED TO ENGINEER/ ARCHITECT FOR FINIAL REVIEW BEFORE INSTALLATION. CONDUIT RUNS ARE TO BE AS HIGH ON THE WALL AS POSSIBLE AND BE INSTALLED HORIZONTAL TO FLOOR.
U. IF COMPLIANCE WITH TWO OR MORE DIFFERING STANDARDS, REQUIREMENTS, DRAWINGS OR SPECIFICATIONS OR ANY COMBINATION THEREOF IS SPECIFIED AND THESE ESTABLISH DIFFERENT OR CONFLICTING REQUIREMENTS FOR MINIMUM QUANTITIES OR QUALITY LEVELS, COMPLY WITH THE MOST STRINGENT REQUIREMENT, THE MOST STRINGENT REQUIREMENT WILL BE THE BETTER QUALITY OR GREATER QUANTITY OF WORK AND WILL TYPICALLY BE THE MORE EXPENSIVE OPTION. REFER UNCERTAINTIES AND REQUIREMENTS THAT ARE DIFFERENT, BUT APPARENTLY EQUAL, TO ENGINEER FOR A DECISION BEFORE PROCEEDING.
V. THE QUANTITY OR QUALITY LEVEL SHOWN OR SPECIFIED SHALL BE THE MINIMUM PROVIDED OR PERFORMED. THE ACTUAL INSTALLATION MAY COMPLY EXACTLY WITH THE MINIMUM QUANTITY OR QUALITY SPECIFIED, OR IT MAY EXCEED THE MINIMUM WITHIN REASONABLE LIMITS. TO COMPLY WITH THESE REQUIREMENTS, INDICATED NUMERIC VALUES ARE MINIMUM OR MAXIMUM, AS APPROPRIATE, FOR THE CONTEXT OF REQUIREMENTS. REFER UNCERTAINTIES TO ENGINEER FOR A DECISION BEFORE PROCEEDING.
W. DESIGN DOCUMENTS MUST BE REPRODUCED IN THEIR ENTIRETY INCLUDING ALL PLANS, SPECIFICATIONS, AND FRONT END DOCUMENTS.
X. ONLY COMPLETE DOCUMENT SETS ARE TO BE DISTRIBUTED TO SUBCONTRACTORS AND SUPPLIERS OF THE CONTRACTOR DURING BIDDING OR CONSTRUCTION.
Y. FAILURE TO REVIEW AND COMPLY WITH A FULL SET OF CONTRACT DOCUMENTS WILL NOT BE ACCEPTED AS A VALID REASON FOR FAILURE TO MEET THE REQUIREMENTS OF THE PLANS AND SPECIFICATIONS.
Z. ALL ABOVE CEILING SYSTEMS AND COMPONENTS INCLUDING, BUT NOT LIMITED TO, MECHANICAL, ELECTRICAL, PLUMBING, FIRE PROTECTION, ETC. SHALL BE COORDINATED SUCH THAT THE SYSTEMS ARE PROPERLY INTEGRATED IN THE SPACE PROVIDED ABOVE THE CEILING AT THE CEILING HEIGHTS NOTED. IT IS THE RESPONSIBILITY OF EACH CONTRACTOR TO COORDINATE PATHWAYS WITH THE SPACE PROVIDED. CEILING HEIGHTS WILL NOT BE MODIFIED.
AA. COORDINATE LOCATIONS OF ALL ELECTRICAL DEVICES WITH ARCHITECTURAL, STRUCTURAL, MECHANICAL, CIVIL, AND INTERIORS PRIOR TO ROUGH-IN. ALL CONFLICTS WITH FINISHES, ADJACENT CONSTRUCTION AND CONSTRUCTION DOCUMENTS ARE TO GENERATE AN RFI FROM THE CONTRACTOR TO THE ENGINEER PRIOR TO PROCEEDING WITH AND COMPLETION OF THE WORK.
BB. WHERE CIRCUIT CONDUCTOR SIZES OR QUANTITIES EXCEED THE EQUIPMENT TERMINATION CAPACITY, COMPRESSION TYPE CABLE REDUCING ADAPTERS; MECHANICAL OR COMPRESSION INLINE SPLICER-REDUCERS; OR MECHANICAL TWO WAY MULTI-TAP TYPE CABLE BLOCKS MAY BE USED TO REDUCE CONDUCTOR SIZE AND/OR QUANTITY TO ALLOW EQUIPMENT TERMINATIONS TO BE MADE. WITH SPLICER-REDUCERS AND CABLE BLOCKS, THE LENGTH OF THE REDUCED SIZE OR QUANTITY OF CONDUCTOR SHALL NOT EXCEED TEN FEET. THE AMPERE RATING OF THE REDUCED QUANTITY OR SIZE CONDUCTORS SHALL NOT BE LESS THAN THE RATING OF THE CIRCUIT OVERCURRENT PROTECTIVE DEVICE.
CC. WHERE REQUIRED BY NEC, PROVIDE CIRCUIT BREAKERS AT SWITCHBOARDS AND PANELBOARDS FEEDING EQUIPMENT OR APPLIANCES WITH A FIXED ATTACHMENT FOR LOCKING THE CIRCUIT BREAKER HANDLE IN THE OFF POSITION.

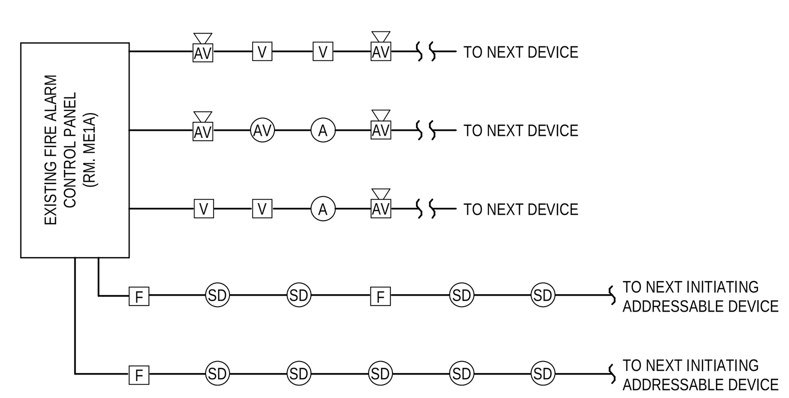


NOTES:
1. THE DESIGN IS BASED ON AN ALLOWABLE SOIL BEARING PRESSURE OF 2500 PSF. IF SUITABLE SOILS ARE NOT FOUND AT THE ELEVATIONS SHOWN, EXCAVATE AND REPLACE WITH ENGINEERED FILL AS DIRECTED BY THE ENGINEER.
2. ALL CONCRETE SHALL ACHIEVE 4000 PSI AT 28 DAYS AND SHALL BE AIR ENTRAINED. CHAMFER EXPOSED EDGES 3/4".
3. PROVIDE OPENINGS FOR GENERATOR PRIMARY AND SECONDARY CONDUITS AS REQUIRED.
4. ADJUST PAD DIMENSIONS FOR EQUIPMENT SUPPLIED. PAD SHALL BE 12 INCHES LONGER AND WIDER THAN EQUIPMENT SUPPLIED.
5. FURNISH AND INSTALL (4) 3/4" x 10' GROUND RODS IN UNDISTRIBUTED SOIL NEAR PAD CORNERS. INTERCONNECT WITH #4/0 BARE COPPER GROUND CABLE. CONNECT TO TRANSFORMER GROUND LUG AND TO MAIN DISCONNECT GROUND BUS WITH #4/0 CABLE.

CONCRETE TRANSFORMER PAD
NOT TO SCALE

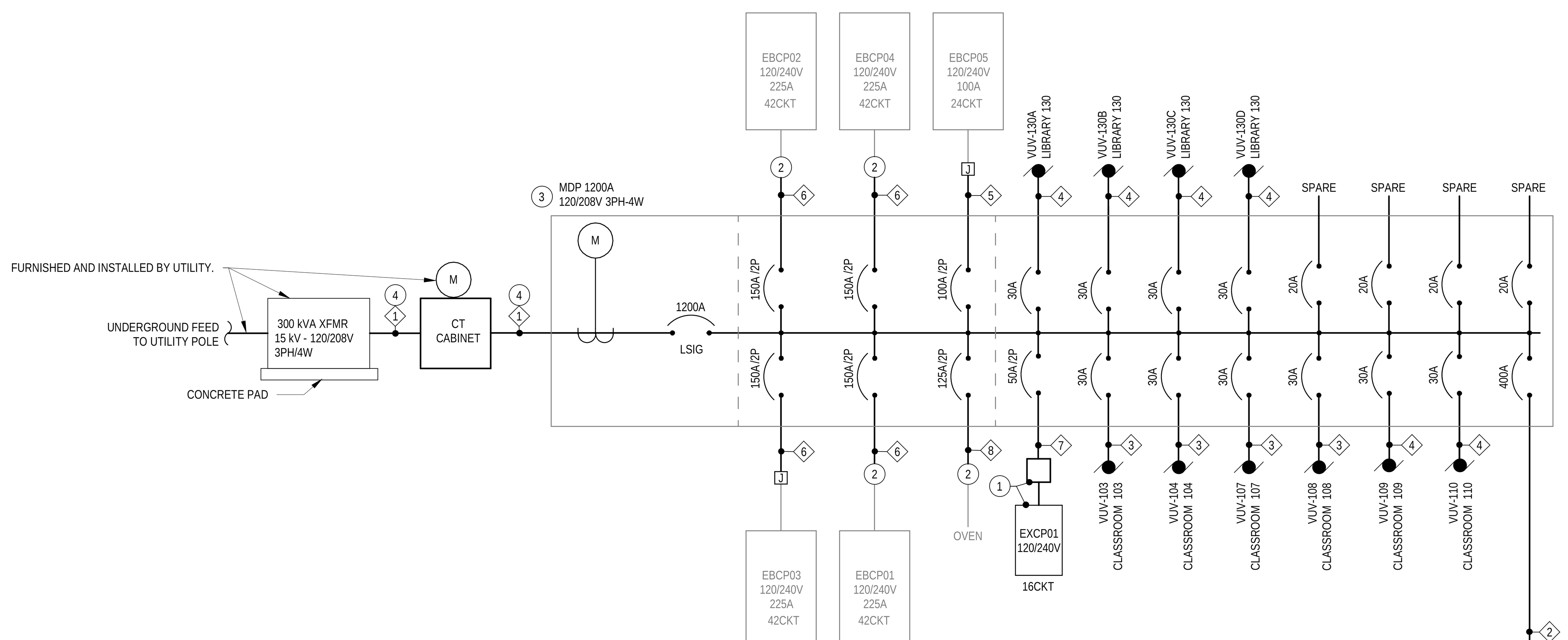


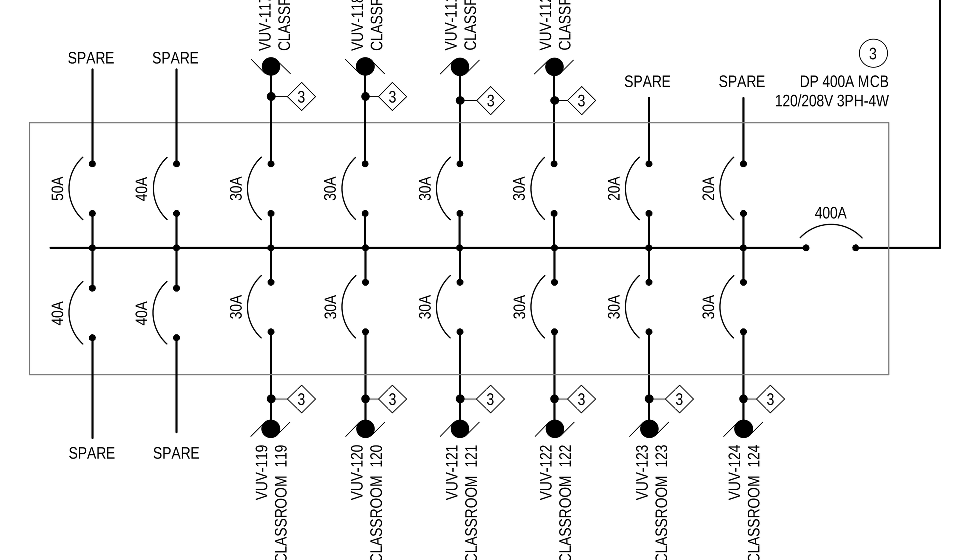
GROUNDING SYSTEM DETAIL
NOT TO SCALE



NOTES:
1. MODIFY AND EXPAND EXISTING SYSTEM AS REQUIRED FOR REMODEL OF SPACE AS SHOWN ON PLANS.
2. FIRE ALARM PROVIDER TO PROVIDE COMPLETE AND FUNCTIONAL CODE COMPLIANT SYSTEM AS DESCRIBED IN PROJECT SPECIFICATION SECTION 28 4631.11. QUANTITIES, LOCATIONS AND TYPES OF DEVICES SHALL BE AS REQUIRED TO MEET ALL APPLICABLE CODES.
3. CONTRACTOR TO UTILIZE EXISTING INTERSTITIAL WIREWAYS FOR DISTRIBUTION OF FIRE ALARM CABLES. REUSE EXISTING PENETRATIONS.

FIRE ALARM RISER DIAGRAM
NOT TO SCALE





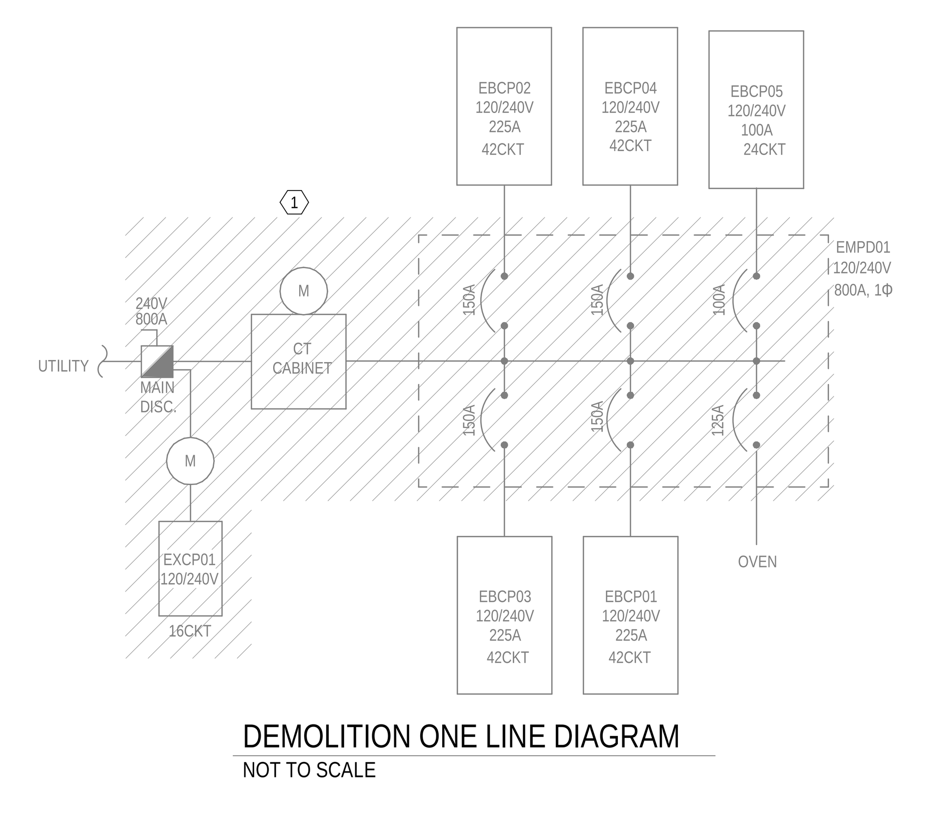
PROPOSED ONE LINE DIAGRAM
NOT TO SCALE

GENERAL PROPOSED ONE LINE NOTES
A. ALL BREAKERS ARE 3-POLE UNLESS NOTED OTHERWISE.

PROPOSED ONE LINE KEYNOTES (#)
1. FURNISH AND INSTALL A 10 kVA INVERTER TO PROVIDE A MINIMUM OF 90 MINUTES OF BATTERY BACK UP FOR NEW EMERGENCY PANEL EXCP01. RECONNECT EXISTING EMERGENCY CIRCUITS TO PANEL.
2. INSTALL 25 KVA BUCK BOOST TRANSFORMER FURNISHED UNDER SEPARATE CONTRACT FOR EXISTING 120/240V-2P LOADS TO NEW MDP.
3. PANEL WILL BE FURNISHED UNDER SEPARATE CONTRACT. CONTRACTOR TO INSTALL PANEL IN LOCATION INDICATED ON PLANS.
4. ROUTE CONDUCTOR UNDERGROUND AT DEPTH REQUIRED BY NEC.

WIRE SIZES ⟨#⟩
1. (3) 4"C, 4-600 kcmil, #3/0 AWG G EACH
2. 3"C, 3-600 kcmil, #3 AWG G
3. 3/4"C, 3 #10 AWG, #10 AWG G
4. 3/4"C, 3 #8 AWG, #10 AWG G
5. 1-1/4"C, 2 #3 AWG, #8 AWG G
6. 2"C, 2 #4/0 AWG, #4 AWG G
7. 3/4"C, 2 #8 AWG, #10 AWG G
8. 1-1/4"C, 2 #1 AWG, #6 AWG G

DEMOLITION ONE LINE KEYNOTES ⟨#⟩
1. DISCONNECT EXISTING CIRCUITS FROM EMDP01 AND EXCP01. REMOVE EMDP01, EXCP01, 800A DISCONNECT SWITCH, CT CABINET, AND METERS.



DEMOLITION ONE LINE DIAGRAM
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GENERAL NOTES AND LEGENDS

REVISIONS

REV	DESCRIPTION	DATE

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WE RECYCLE
THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK
WHITE

DEMOLITION PLAN - AREA A
1/8" = 1'-0"

1 ELECTRICAL ROOM PLAN - DEMOLITION
1/4" = 1'-0"

GENERAL DEMOLITION NOTES

A. DEMOLITION NOTES ARE BASED UPON FIELD OBSERVATION AND EXISTING RECORD DOCUMENTS. THE ELECTRICAL CONTRACTOR SHALL VERIFY EXACT CONDITIONS AT THE SITE AND REPORT DISCREPANCIES TO THE ARCHITECT/ENGINEER BEFORE DISTURBING THE INSTALLATION.

B. THE SCOPE OF THE REQUIRED DEMOLITION IS NOT LIMITED TO THE ITEMS OR WORK INDICATED ON THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL DETERMINE THE NATURE AND EXTENT OF WORK REQUIRED. THE CONTRACTOR ACCEPTS EXISTING SITE CONDITIONS AT THE START OF DEMOLITION.

C. WHERE ELECTRICAL COMPONENTS ARE SHOWN TO BE REMOVED, RECONNECT REMAINING COMPONENTS TO EXISTING CIRCUIT(S) AND PROVIDE TEMPORARY CIRCUIT(S) DURING CONSTRUCTION AS REQUIRED.

D. WHERE THE DRAWINGS SHOW DEVICES OR EQUIPMENT TO BE PERMANENTLY REMOVED, REMOVE CONDUCTORS BACK TO SOURCE. TURN CIRCUIT BREAKER OFF AND LABEL THE CIRCUIT BREAKER AS A SPARE ON A NEWLY PRINTED PANELBOARD DIRECTORY.

E. REMOVE ALL ABANDONED CONDUIT. THE ELECTRICAL CONTRACTOR SHALL CUT CONDUIT FLUSH WITH WALLS AND FLOORS UNLESS OTHERWISE NOTED; PATCH ALL SURFACES AND PROVIDE FIRESTOPPING WHERE REQUIRED.

F. REPAIR ADJACENT CONSTRUCTION AND FINISHES WHERE DAMAGED BY DEMOLITION WORK. REPAIRS SHALL BE MADE TO RETURN SPACE TO ORIGINAL CONDITION PRIOR TO COMPLETION OF THE PROJECT.

G. EQUIPMENT AND DEVICES SHOWN AS DASHED ON THE DRAWINGS ARE TO BE REMOVED.

H. PROVIDE TEMPORARY WIRING AND CONNECTIONS TO MAINTAIN OPERATION OF EXISTING SYSTEMS DURING CONSTRUCTION. CONDITIONS SHALL BE RETURNED TO NORMAL AT THE CLOSE OF THE PROJECT.

I. DISPOSE OF ALL MATERIALS AND EQUIPMENT REMOVED THAT ARE NOT TO BE TURNED OVER TO THE OWNER.

J. COORDINATE ALL DISRUPTIONS OF SERVICE WITH THE OWNER. DO NOT PROCEED WITH DISRUPTIONS WITHOUT OWNER'S APPROVAL.

K. REMOVE ALL CONDUIT, CONDUCTORS, CABLES, JUNCTION BOXES, HANGERS AND ALL OTHER ASSOCIATED SPECIFICATION DIVISION 26, 27 AND 28 DEVICES LOCATED IN THE SCOPE OF THE WORK AREA. REMOVE BACK TO SOURCE PANEL, TERMINATION OR SPLICE LOCATED OUTSIDE OF PROJECT SCOPE OF WORK AREA, EXCEPT WHERE NOTED OTHERWISE.

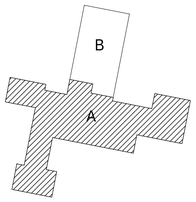
L. CIRCUITS INDICATED TO ORIGINATE IN EXISTING PANELBOARDS ARE FOR REFERENCE ONLY. FIELD VERIFY QUANTITY OF EXISTING SPARE CIRCUIT BREAKERS AND IDENTIFY THOSE MADE AVAILABLE DURING DEMOLITION. UTILIZE SPARE CIRCUIT BREAKERS TO SERVE NEW LOADS. PROVIDE NEW SINGLE AND MULTI-POLE BREAKERS WHERE INDICATED ON RISER AND/OR SCHEDULE AND IDENTIFY THOSE WHICH WILL REMAIN AS SPARES. PROVIDE A PRINTED, UPDATED PANELBOARD SCHEDULE.

M. TRACE ALL EXISTING CONDUCTORS AND CABLES RUNNING THROUGH PROJECT SCOPE OF WORK AREA THAT DO NOT CONNECT TO COMPONENTS INSIDE THE SCOPE OF WORK. REMOVE COMPONENTS THAT HAVE BEEN ABANDONED.

N. DISCONNECT ELECTRICAL CONNECTIONS TO EXISTING HORIZONTAL UNIT VENTILATORS IN ALL CLASSROOMS AND LIBRARY 130 AND REMOVE BACK TO SOURCE PANEL. SEE MECHANICAL DRAWINGS FOR ADDITIONAL DEMOLITION INFORMATION.

DEMOLITION KEYNOTES (#)

1. DISCONNECT AND REMOVE ALL ELECTRICAL EQUIPMENT WITHIN ROOM AS INDICATED.



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DEMOLITION PLAN - AREA A

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WE RECYCLE
THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK
WHITE

GENERAL DEMOLITION NOTES

A. DEMOLITION NOTES ARE BASED UPON FIELD OBSERVATION AND EXISTING RECORD DOCUMENTS. THE ELECTRICAL CONTRACTOR SHALL VERIFY EXACT CONDITIONS AT THE SITE AND REPORT DISCREPANCIES TO THE ARCHITECT/ENGINEER BEFORE DISTURBING THE INSTALLATION.

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E. REMOVE ALL ABANDONED CONDUIT. THE ELECTRICAL CONTRACTOR SHALL CUT CONDUIT FLUSH WITH WALLS AND FLOORS UNLESS OTHERWISE NOTED, PATCH ALL SURFACES AND PROVIDE FIRESTOPPING WHERE REQUIRED.

F. REPAIR ADJACENT CONSTRUCTION AND FINISHES WHERE DAMAGED BY DEMOLITION WORK. REPAIRS SHALL BE MADE TO RETURN SPACE TO ORIGINAL CONDITION PRIOR TO COMPLETION OF THE PROJECT.

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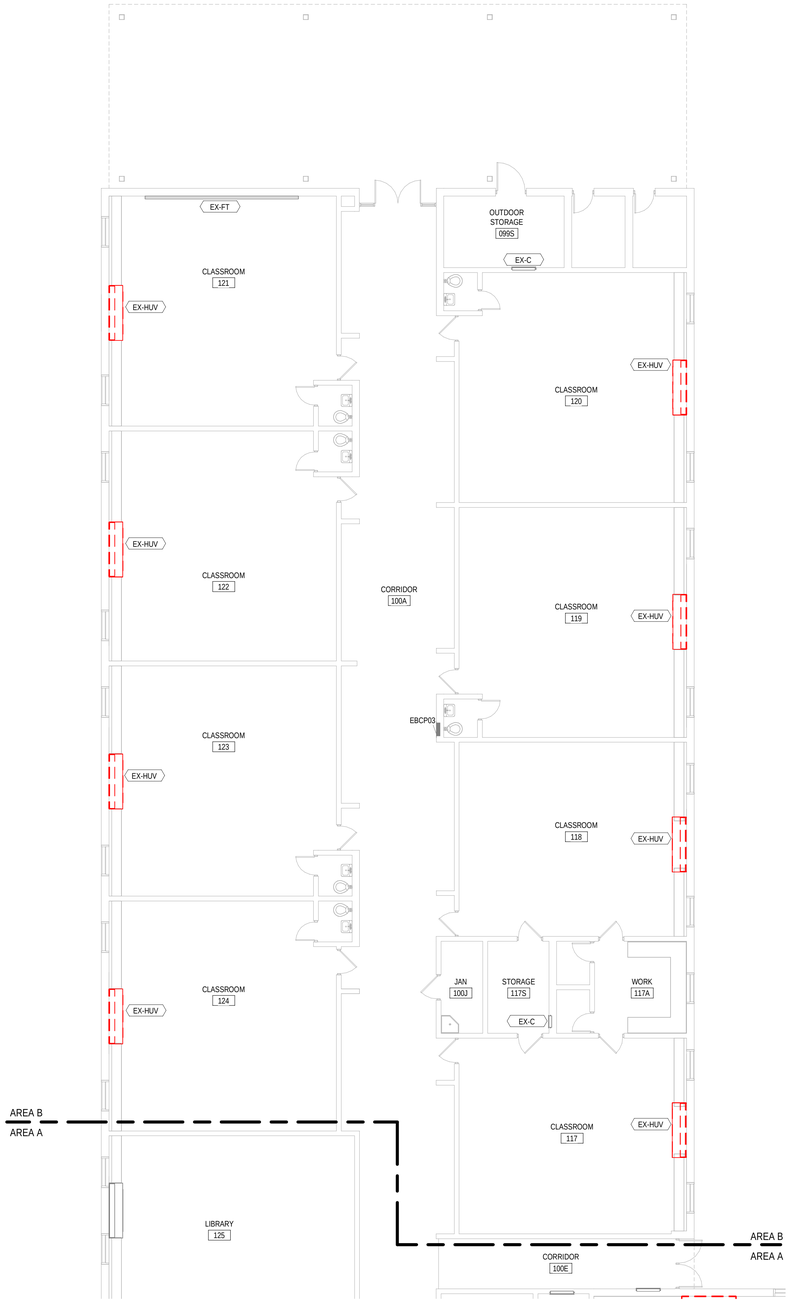
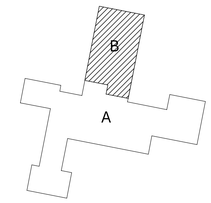
M. TRACE ALL EXISTING CONDUCTORS AND CABLES RUNNING THROUGH PROJECT SCOPE OF WORK AREA THAT DO NOT CONNECT TO COMPONENTS INSIDE THE SCOPE OF WORK. REMOVE COMPONENTS THAT HAVE BEEN ABANDONED.

N. DISCONNECT ELECTRICAL CONNECTIONS TO EX-HUVs IN ALL CLASSROOMS AND LIBRARY 130 AND REMOVE BACK TO SOURCE PANEL. SEE MECHANICAL DRAWINGS FOR ADDITIONAL DEMOLITION INFORMATION.



DEMOLITION PLAN - AREA B
1/8" = 1'-0"



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DEMOLITION PLAN - AREA B

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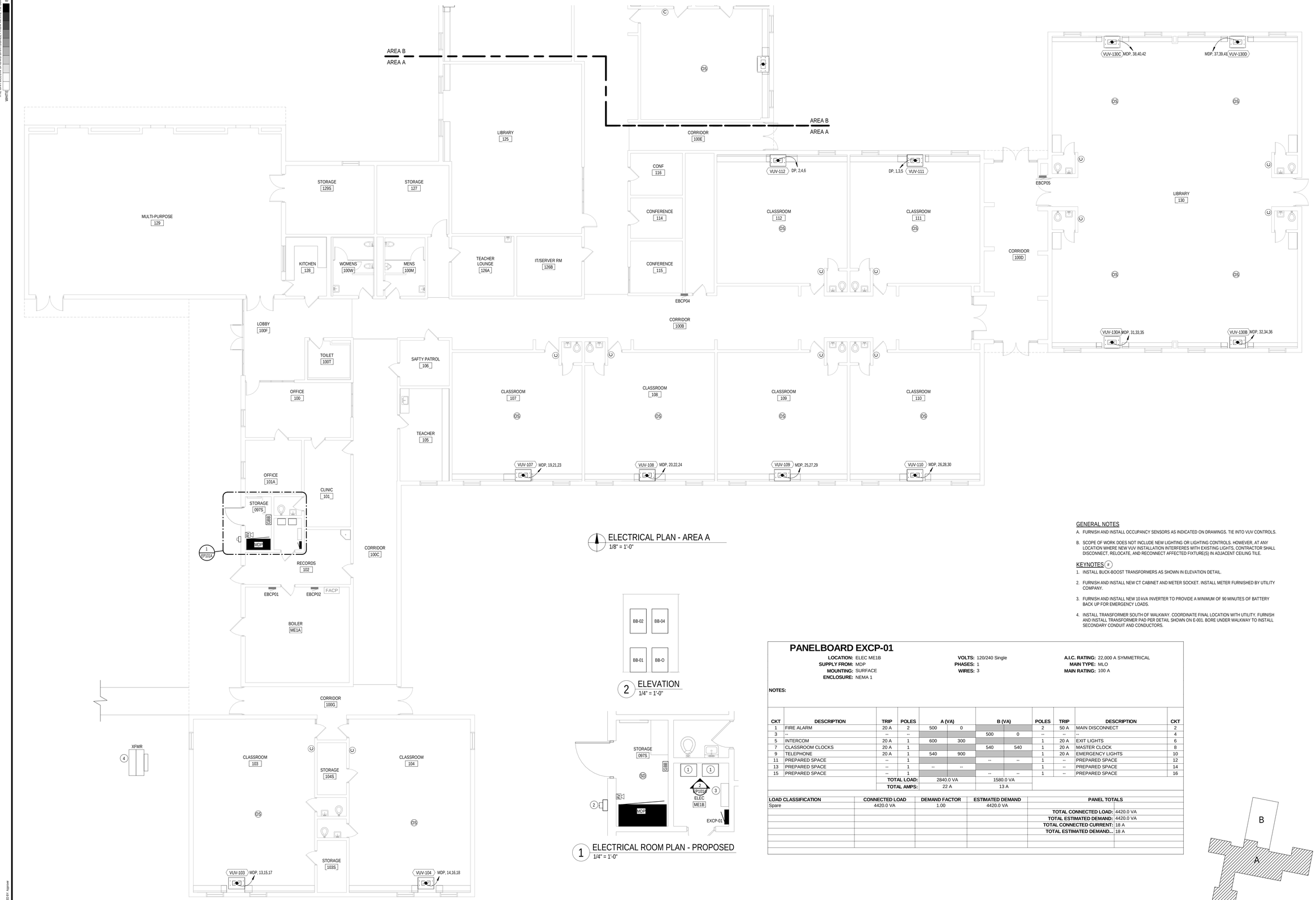
WE RECYCLE
THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK
WHITE



ELECTRICAL PLAN - AREA A
1/8" = 1'-0"

2 ELEVATION
1/4" = 1'-0"

1 ELECTRICAL ROOM PLAN - PROPOSED
1/4" = 1'-0"

GENERAL NOTES
A. FURNISH AND INSTALL OCCUPANCY SENSORS AS INDICATED ON DRAWINGS. TIE INTO VUV CONTROLS.

B. SCOPE OF WORK DOES NOT INCLUDE NEW LIGHTING OR LIGHTING CONTROLS. HOWEVER, AT ANY LOCATION WHERE NEW VUV INSTALLATION INTERFERES WITH EXISTING LIGHTS, CONTRACTOR SHALL DISCONNECT, RELOCATE, AND RECONNECT AFFECTED FIXTURE(S) IN ADJACENT CEILING TILE.

KEYNOTES (#)
1. INSTALL BUCK-BOOST TRANSFORMERS AS SHOWN IN ELEVATION DETAIL.
2. FURNISH AND INSTALL NEW CT CABINET AND METER SOCKET. INSTALL METER FURNISHED BY UTILITY COMPANY.
3. FURNISH AND INSTALL NEW 10 kVA INVERTER TO PROVIDE A MINIMUM OF 90 MINUTES OF BATTERY BACK UP FOR EMERGENCY LOADS.
4. INSTALL TRANSFORMER SOUTH OF WALKWAY. COORDINATE FINAL LOCATION WITH UTILITY. FURNISH AND INSTALL TRANSFORMER PAD PER DETAIL SHOWN ON E-001. BORE UNDER WALKWAY TO INSTALL SECONDARY CONDUIT AND CONDUCTORS.

PANELBOARD EXCP-01

LOCATION: ELEC ME1B
SUPPLY FROM: MDP
MOUNTING: SURFACE
ENCLOSURE: NEMA 1

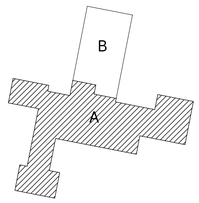
VOLTS: 120/240 Single
PHASES: 1
WIRES: 3

A.I.C. RATING: 22,000 A SYMMETRICAL
MAIN TYPE: MLO
MAIN RATING: 100 A

NOTES:

CKT	DESCRIPTION	TRIP	POLES	A (VA)		B (VA)		POLES	TRIP	DESCRIPTION	CKT
1	FIRE ALARM	20 A	2	500	0			2	50 A	MAIN DISCONNECT	2
3	--	--	--			500	0	--	--	--	4
5	INTERCOM	20 A	1	600	300			1	20 A	EXIT LIGHTS	6
7	CLASSROOM CLOCKS	20 A	1			540	540	1	20 A	MASTER CLOCK	8
9	TELEPHONE	20 A	1	540	900			1	20 A	EMERGENCY LIGHTS	10
11	PREPARED SPACE	--	1			--	--	1	--	PREPARED SPACE	12
13	PREPARED SPACE	--	1	--	--			1	--	PREPARED SPACE	14
15	PREPARED SPACE	--	1			--	--	1	--	PREPARED SPACE	16
		TOTAL LOAD:		2840.0 VA		1580.0 VA					
		TOTAL AMPS:		22 A		13 A					

LOAD CLASSIFICATION	CONNECTED LOAD	DEMAND FACTOR	ESTIMATED DEMAND	PANEL TOTALS	
Spare	4420.0 VA	1.00	4420.0 VA		
				TOTAL CONNECTED LOAD:	4420.0 VA
				TOTAL ESTIMATED DEMAND:	4420.0 VA
				TOTAL CONNECTED CURRENT:	18 A
				TOTAL ESTIMATED DEMAND...	18 A



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ELECTRICAL PLAN - AREA A

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WHITE

PANELBOARD MDP

LOCATION: STORAGE 097S
SUPPLY FROM: XFMR
MOUNTING: SURFACE
ENCLOSURE: NEMA 1

VOLTS: 120/208 Wye
PHASES: 3
WIRES: 4

A.I.C. RATING: 25,000 A SYMMETRICAL
MAIN TYPE: MCB
MAIN RATING: 1200 A

NOTES:
1. INSTALL PANEL PURCHASED UNDER SEPERATE CONTRACT. 2. INDIVIDUAL EXISTING LOADS ESTIMATED BASED ON TOTAL DEMAND LOAD PROVIDED BY UTILITY.

CKT	DESCRIPTION	TRIP	POLES	A		B		C		POLES	TRIP	DESCRIPTION	CKT
1	BB-01 / EBCP-01 (E)	150 A	2	9000	9000					2	20 A	BB-02 / EBCP-02 (E)	2
3	--	--	--			9000	9000			--	--	--	4
5	EBCP-03 (E)	150 A	2					9000	9000	2	20 A	BB-04 / EBCP-04 (E)	6
7	--	--	--	9000	9000					--	--	--	8
9	EBCP-05 (E)	100 A	2			6060	7575			2	125 A	BB-O / OVEN (E)	10
11	--	--	--					6060	7575	--	--	--	12
13	VUV-103, CLASSROOM 103	30 A	3	2474	2474					3	30 A	VUV-104, CLASSROOM 104	14
15	--	--	--			2474	2474			--	--	--	16
17	--	--	--					2474	2474	--	--	--	18
19	VUV-107, CLASSROOM 107	30 A	3	2474	2474					3	30 A	VUV-108, CLASSROOM 108	20
21	--	--	--			2474	2474			--	--	--	22
23	--	--	--					2474	2474	--	--	--	24
25	VUV-109, CLASSROOM 109	30 A	3	2474	2474					3	30 A	VUV-110, CLASSROOM 110	26
27	--	--	--			2474	2474			--	--	--	28
29	--	--	--					2474	2474	--	--	--	30
31	VUV-130A, LIBRARY 130	30 A	3	2474	2474					3	30 A	VUV-130B, LIBRARY 130	32
33	--	--	--			2474	2474			--	--	--	34
35	--	--	--					2474	2474	--	--	--	36
37	VUV-130D, LIBRARY 130	30 A	3	2474	2474					3	30 A	VUV-130C, LIBRARY 130	38
39	--	--	--			2474	2474			--	--	--	40
41	--	--	--					2474	2474	--	--	--	42
43	SPARE BREAKER	20 A	3	0	0					3	20 A	SPARE BREAKER	44
45	--	--	--			0	0			--	--	--	46
47	--	--	--					0	0	--	--	--	48
49	SPARE BREAKER	20 A	3	0	--					3	--	PREPARED SPACE	50
51	--	--	--			0	--			--	--	--	52
53	--	--	--					0	--	--	--	--	54
55	EXCP-01	50 A	2	2840	0					2	20 A	SPARE BREAKER	56
57	--	--	--			1580	0			--	--	--	58
59	PREPARED SPACE	--	1					--	24738	3	400 A	DP	60
61	PREPARED SPACE	--	1	--	24738					--	--	--	62
63	PREPARED SPACE	--	1			--	24738			--	--	--	64
		TOTAL LOAD:		88315.1 VA		82690.1 VA		81110.1 VA					
		TOTAL AMPS:		738 A		691 A		676 A					

LOAD CLASSIFICATION	CONNECTED LOAD	DEMAND FACTOR	ESTIMATED DEMAND	PANEL TOTALS	
MOTOR	148425.4 VA	1.01	150280.7 VA		
Spare	103690.0 VA	1.00	103690.0 VA	**TOTAL CONNECTED LOAD:**	252115.4 VA
				TOTAL EST. DEMAND:	253970.7 VA
				TOTAL CONNECTED CURRENT:	700 A
				TOTAL EST. DEMAND CURRENT:	705 A

PANELBOARD DP

LOCATION: JAN 100J
SUPPLY FROM: MDP
MOUNTING: SURFACE
ENCLOSURE: NEMA 1

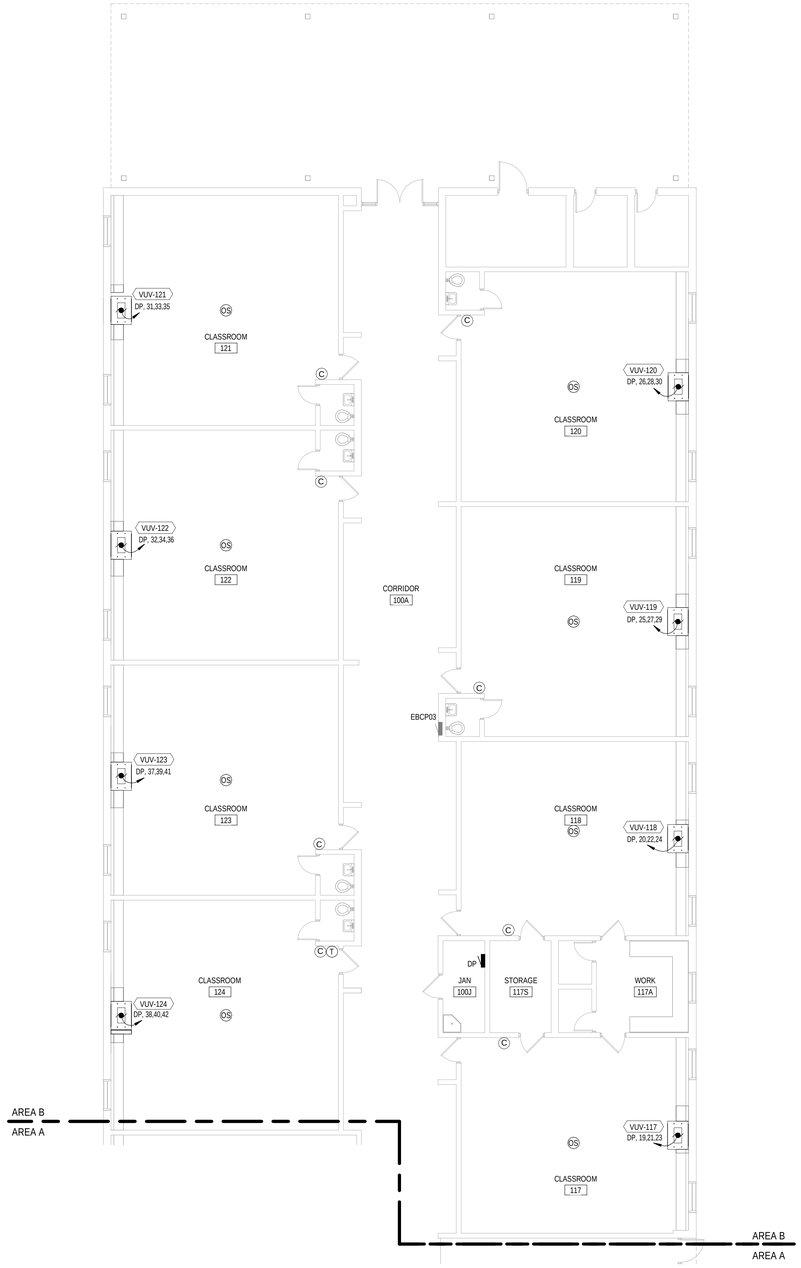
VOLTS: 120/208 Wye
PHASES: 3
WIRES: 4

A.I.C. RATING: 22,000 A SYMMETRICAL
MAIN TYPE: MCB
MAIN RATING: 400 A

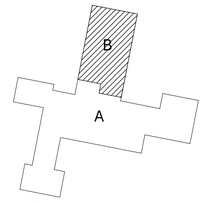
NOTES:
INSTALL PANEL PURCHASED UNDER SEPERATE CONTRACT.

CKT	DESCRIPTION	TRIP	POLES	A		B		C		POLES	TRIP	DESCRIPTION	CKT
1	VUV-111, CLASSROOM 111	30 A	3	2474	2474					3	30 A	VUV-112, CLASSROOM 112	2
3	--	--	--			2474	2474			--	--	--	4
5	--	--	--					2474	2474	--	--	--	6
7	SPARE BREAKER	40 A	3	0	0					3	40 A	SPARE BREAKER	8
9	--	--	--			0	0			--	--	--	10
11	--	--	--					0	0	--	--	--	12
13	SPARE BREAKER	40 A	3	0	0					3	50 A	SPARE BREAKER	14
15	--	--	--			0	0			--	--	--	16
17	--	--	--					0	0	--	--	--	18
19	VUV-117, CLASSROOM 117	30 A	3	2474	2474					3	30 A	VUV-118, CLASSROOM 118	20
21	--	--	--			2474	2474			--	--	--	22
23	--	--	--					2474	2474	--	--	--	24
25	VUV-119, CLASSROOM 119	30 A	3	2474	2474					3	30 A	VUV-120, CLASSROOM 120	26
27	--	--	--			2474	2474			--	--	--	28
29	--	--	--					2474	2474	--	--	--	30
31	VUV-121, CLASSROOM 121	30 A	3	2474	2474					3	30 A	VUV-122, CLASSROOM 122	32
33	--	--	--			2474	2474			--	--	--	34
35	--	--	--					2474	2474	--	--	--	36
37	VUV-123, CLASSROOM 123	30 A	3	2474	2474					3	30 A	VUV-124, CLASSROOM 124	38
39	--	--	--			2474	2474			--	--	--	40
41	--	--	--					2474	2474	--	--	--	42
43	SPARE BREAKER	20 A	3	0	0					3	20 A	SPARE BREAKER	44
45	--	--	--			0	0			--	--	--	46
47	--	--	--					0	0	--	--	--	48
49	SPARE BREAKER	30 A	3	0	--					3	--	PREPARED SPACE	50
51	--	--	--			0	--			--	--	--	52
53	--	--	--					0	--	--	--	--	54
		TOTAL LOAD:		24737.6 VA		24737.6 VA		24737.6 VA					
		TOTAL AMPS:		206 A		206 A		206 A					

LOAD CLASSIFICATION	CONNECTED LOAD	DEMAND FACTOR	ESTIMATED DEMAND	PANEL TOTALS	
MOTOR	74212.7 VA	1.03	76068.0 VA		
				TOTAL CONNECTED LOAD:	74212.7 VA
				TOTAL ESTIMATED DEMAND:	76068.0 VA
				TOTAL CONNECTED CURRENT:	206 A
				TOTAL ESTIMATED DEMAND...	211 A



ELECTRICAL PLAN - AREA B
1/8" = 1'-0"



KEY PLAN
NOT TO SCALE

GENERAL NOTES

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ELECTRICAL PLAN - AREA B

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Project Manual

Lansing School District SB-0051
Lyons Elementary Mechanical Improvements
Ingham County, Michigan

C2AE Project #22-0179

November 11, 2022

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architecture • engineering

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PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Requirements:
   1. Document 002600 "Procurement Substitution Procedures" for requirements for substitution requests prior to award of Contract.
   2. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.2 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
   1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
   2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.3 ACTION SUBMITTALS

A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
   1. Substitution Request Form: Use form provided in Project Manual.
   2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
      a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
      b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
      c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
      d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
      e. Samples, where applicable or requested.
      f. Certificates and qualification data, where applicable or requested.

g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects and owners.
h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
j. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
k. Cost information, including a proposal of change, if any, in the Contract Sum.
l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor through Construction Manager of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
   a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
   b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.4 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.5 PROCEDURES

A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

1.6 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
   1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
      a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
      b. Substitution request is fully documented and properly submitted.
      c. Requested substitution will not adversely affect Contractor's construction schedule.
      d. Requested substitution has received necessary approvals of authorities having jurisdiction.
      e. Requested substitution is compatible with other portions of the Work.
      f. Requested substitution has been coordinated with other portions of the Work.
      g. Requested substitution provides specified warranty.
      h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Not allowed.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

REQUEST FOR SUBSTITUTION

TO: _____ **DATE:** _____

PROJECT: _____

SECTION	**PARAGRAPH**	**SPECIFIED ITEM**
_____	_____	_____

PROPOSED SUBSTITUTION: _____ **MODEL:** _____

MANUFACTURER: _____ **PHONE:** (____) _____

Include product description, specifications, drawings, photographs, performance and test data adequate for evaluation. Clearly identify applicable portions of the data. Also include description of changes to contract documents that would be required as a result of the substitution.

The undersigned states that the following line items, unless modified on attachments, are correct:

A. I have read and fully understand the conditions for substitutions outlined in this specification section.

B. The proposed substitution does not affect dimensions shown on drawings.

C. The undersigned will reimburse architect for any building design changes required due to the substitution, including engineering, detailing, and services associated with re-approval by authorities.

D. I will coordinate installation and make both known and unforeseen changes to other work required for substitution at no additional cost to the owner.

E. The proposed substitution will have no adverse effect on other trades, the construction schedule, or specified warranty requirements.

F. Maintenance and service parts will be locally available for the proposed substitution.

G. The undersigned further states that the function, appearance, and quality of the proposed substitutions are equivalent or superior to the specified item.

SUBMITTED BY: _____

SIGNATURE _____

FIRM _____

ADDRESS _____

_____

TELEPHONE (____) _____

FAX (____) _____

FOR USE BY C2AE

ACCEPTED **ACCEPTED AS NOTED**

NOT ACCEPTED **RECEIVED TOO LATE**

BY _____

DATE _____

REMARKS _____

SECTION 013100 – PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
   1. General coordination procedures.
   2. Coordination drawings.
   3. RFIs.
   4. Digital project management procedures.
   5. Project meetings.

B. Related Requirements:
   1. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
   2. Section 019113 "General Commissioning Requirements" for coordinating the Work with Owner's Commissioning Authority.

1.2 INFORMATIONAL SUBMITTALS

A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
   1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
   2. Number and title of related Specification Section(s) covered by subcontract.
   3. Drawing number and detail references, as appropriate, covered by subcontract.

1.3 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.
   1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
   2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
   3. Make adequate provisions to accommodate items scheduled for later installation.

B. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
   1. Preparation of Contractor's construction schedule.
   2. Preparation of the schedule of values.
   3. Installation and removal of temporary facilities and controls.
   4. Delivery and processing of submittals.
   5. Progress meetings.
   6. Preinstallation conferences.
   7. Project closeout activities.
   8. Startup and adjustment of systems.

1.4 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
   1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
      a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
      b. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:
   1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
   2. Plenum Space: Indicate subframing for support of ceiling, raised access floor, and wall systems, mechanical and electrical equipment, and related Work. Locate components within plenums to accommodate layout of light fixtures and other components indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
   3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
   4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.

5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
6. Review: Architect will review coordination drawings to confirm that, in general, the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make suitable modifications and resubmit.

1.5 REQUEST FOR INFORMATION (RFI)

A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
1. Architect will return without response those RFIs submitted to Architect by other entities controlled by Contractor.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Owner name.
2. Owner's Project number.
3. Name of Architect.
4. Architect's Project number.
5. Date.
6. Name of Contractor.
7. RFI number, numbered sequentially.
8. RFI subject.
9. Specification Section number and title and related paragraphs, as appropriate.
10. Drawing number and detail references, as appropriate.
11. Field dimensions and conditions, as appropriate.
12. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
13. Contractor's signature.
14. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Architect.

D. Architect's and Construction Manager's Action: Architect and Construction Manager will review each RFI, determine action required, and respond. Allow three days for Architect's response for each RFI. RFIs received by Architect or Construction Manager after 1:00 p.m. will be considered as received the following working day.
   1. The following Contractor-generated RFIs will be returned without action:
      a. Requests for approval of submittals.
      b. Requests for approval of substitutions.
      c. Requests for approval of Contractor's means and methods.
      d. Requests for coordination information already indicated in the Contract Documents.
      e. Requests for adjustments in the Contract Time or the Contract Sum.
      f. Requests for interpretation of Architect's actions on submittals.
      g. Incomplete RFIs or inaccurately prepared RFIs.
   2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect or Construction Manager of additional information.
   3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."
      a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect and Construction Manager in writing within five days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log [weekly] <Insert time>. [Use software log that is part of web-based Project management software.] [Include the following:] [Software log with not less than the following:]
   1. Project name.
   2. Name and address of Contractor.
   3. Name and address of Architect and Construction Manager.
   4. RFI number including RFIs that were returned without action or withdrawn.
   5. RFI description.
   6. Date the RFI was submitted.
   7. Date Architect's and Construction Manager's response was received.

F. On receipt of Architect's and Construction Manager's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect and Construction Manager within three days if Contractor disagrees with response.

1.6 DIGITAL PROJECT MANAGEMENT PROCEDURES

A. Architect's Data Files Not Available: Architect will not provide Architect's CAD drawing digital data files for Contractor's use during construction.

B. PDF Document Preparation: Where PDFs are required to be submitted to Architect, prepare 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.
   3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other sections and when required for coordination with other construction.
   1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect, Construction Manager of scheduled meeting dates.
   2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
      a. Contract Documents.
      b. Options.
      c. Related RFIs.
      d. Related Change Orders.
      e. Purchases.
      f. Deliveries.
      g. Submittals.
      h. Sustainable design requirements.
      i. Review of mockups.
      j. Possible conflicts.
      k. Compatibility requirements.
      l. Time schedules.
      m. Weather limitations.
      n. Manufacturer's written instructions.
      o. Warranty requirements.
      p. Compatibility of materials.
      q. Acceptability of substrates.
      r. Temporary facilities and controls.
      s. Space and access limitations.
      t. Regulations of authorities having jurisdiction.
      u. Testing and inspecting requirements.
      v. Installation procedures.
      w. Coordination with other work.
      x. Required performance results.
      y. Protection of adjacent work.

z. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Submittal schedule requirements.
   2. Administrative and procedural requirements for submittals.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect's and Construction Manager'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 and Construction Manager'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."

1.3 SUBMITTAL SCHEDULE

A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and Construction Manager and additional time for handling and reviewing submittals required by those corrections.

1.4 SUBMITTAL FORMATS

A. Submittal Information: Include the following information in each submittal:
   1. Project name.
   2. Date.
   3. Name of Architect.
   4. Name of Construction Manager.
   5. Name of Contractor.
   6. Name of firm or entity that prepared submittal.
   7. Names of subcontractor, manufacturer, and supplier.
   8. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier; and alphanumeric suffix for resubmittals.
   9. Category and type of submittal.
   10. Submittal purpose and description.
   11. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
   12. Drawing number and detail references, as appropriate.

13. Indication of full or partial submittal.
14. Location(s) where product is to be installed, as appropriate.
15. Other necessary identification.
16. Remarks.
17. Signature of transmitter.

B. Options: Identify options requiring selection by Architect.

C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect and Construction Manager on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.

D. Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

E. Submittals for Utilizing Web-Based Project Management Software: Prepare submittals as PDF files, or other format indicated by Project management software.

1.5 SUBMITTAL PROCEDURES

A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
1. Email: Prepare submittals as PDF package, and transmit to Architect by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Architect.
2. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project management software website. Enter required data in web-based software site to fully identify submittal.
3. Paper: Prepare submittals in paper form, and deliver to Architect.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.

C. 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. Resubmittal Review: Allow 15 days for review of each resubmittal.

D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

F. 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 and Construction Manager's action stamp.

1.6 SUBMITTAL REQUIREMENTS

A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:
    a. Manufacturer's catalog cuts.
    b. Manufacturer's product specifications.
    c. Standard color charts.
    d. Statement of compliance with specified referenced standards.
    e. Testing by recognized testing agency.
    f. Application of testing agency labels and seals.
    g. Notation of coordination requirements.
    h. Availability and delivery time information.
4. For equipment, include the following in addition to the above, as applicable:
    a. Wiring diagrams that show factory-installed wiring.
    b. Printed performance curves.
    c. Operational range diagrams.
    d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
5. Submit Product Data before Shop Drawings, and before or concurrent with Samples.

B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
   1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
      a. Identification of products.
      b. Schedules.
      c. Compliance with specified standards.
      d. Notation of coordination requirements.
      e. Notation of dimensions established by field measurement.
      f. Relationship and attachment to adjoining construction clearly indicated.
      g. Seal and signature of professional engineer if specified.

C. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.
   1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
   2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
      a. Project name and submittal number.
      b. Generic description of Sample.
      c. Product name and name of manufacturer.
      d. Sample source.
      e. Number and title of applicable Specification Section.
      f. Specification paragraph number and generic name of each item.
   3. Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample characteristics, and identification information for record.
   4. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
   5. Paper Transmittal: Include paper transmittal including complete submittal information indicated.
   6. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
      a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
      b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
   7. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

a. Number of Samples: Submit three sets of Samples. Architect and Construction Manager will retain two Sample sets; remainder will be returned.
   1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
   2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.

G. Certificates:
   1. Certificates and Certifications Submittals: Submit 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. Provide a notarized signature where indicated.
   2. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
   3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
   4. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
   5. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
   6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

H. Test and Research Reports:
   1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for substrate preparation and primers required.
   2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
   3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
   4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
   5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
   6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
      a. Name of evaluation organization.
      b. Date of evaluation.
      c. Time period when report is in effect.
      d. Product and manufacturers' names.
      e. Description of product.
      f. Test procedures and results.
      g. Limitations of use.

1.7 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 insufficient 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 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.

1.8 CONTRACTOR'S REVIEW

A. Action Submittals 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 and Construction Manager.

B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp. Include 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.
   1. Architect will not review submittals received from Contractor that do not have Contractor's review and approval.

1.9 ARCHITECT'S AND CONSTRUCTION MANAGER'S REVIEW

A. Action Submittals: Architect and Construction Manager will review each submittal, indicate corrections or revisions required**, and return it**.
   1. PDF Submittals: Architect and Construction Manager will indicate, via markup on each submittal, the appropriate action.

B. Informational Submittals: Architect and Construction Manager will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Architect will discard submittals received from sources other than Contractor.

F. Submittals not required by the Contract Documents will be returned by Architect without action.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013300

REQUEST FOR SUBSTITUTION

TO: _____ **DATE:** _____

PROJECT: _____

SECTION	**PARAGRAPH**	**SPECIFIED ITEM**

PROPOSED SUBSTITUTION: _____ **MODEL:** _____

MANUFACTURER: _____ **PHONE:** (____) _____

Include product description, specifications, drawings, photographs, performance and test data adequate for evaluation. Clearly identify applicable portions of the data. Also include description of changes to contract documents that would be required as a result of the substitution.

The undersigned states that the following line items, unless modified on attachments, are correct:

A. I have read and fully understand the conditions for substitutions outlined in this specification section.

B. The proposed substitution does not affect dimensions shown on drawings.

C. The undersigned will reimburse architect for any building design changes required due to the substitution, including engineering, detailing, and services associated with re-approval by authorities.

D. I will coordinate installation and make both known and unforeseen changes to other work required for substitution at no additional cost to the owner.

E. The proposed substitution will have no adverse effect on other trades, the construction schedule, or specified warranty requirements.

F. Maintenance and service parts will be locally available for the proposed substitution.

G. The undersigned further states that the function, appearance, and quality of the proposed substitutions are equivalent or superior to the specified item.

SUBMITTED BY: _____

SIGNATURE _____

FIRM _____

ADDRESS _____

_____

TELEPHONE (____) _____

FAX (____) _____

FOR USE BY C2AE

ACCEPTED **ACCEPTED AS NOTED**

NOT ACCEPTED **RECEIVED TOO LATE**

BY _____

DATE _____

REMARKS _____

SECTION 024119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Demolition and removal of selected portions of building or structure.

1.2 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
   1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.3 INFORMATIONAL SUBMITTALS

A. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician.

1.4 CLOSEOUT SUBMITTALS

A. Inventory of items that have been removed and salvaged.

1.5 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.6 FIELD CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   1. Hazardous materials will be removed by Owner before start of the Work.
   2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
   1. Maintain fire-protection facilities in service during selective demolition operations.

G. Arrange selective demolition schedule so as not to interfere with Owner's operations.

1.7 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

C. Inventory and record the condition of items to be removed and salvaged.

3.2 PREPARATION

A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
   1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
   2. Arrange to shut off utilities with utility companies.
   3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
   4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
      a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
      b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
      c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
      d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
      e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
      f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
      g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.4 PROTECTION

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

C. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
   1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
   2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
   3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
   4. Maintain fire watch during and for at least four hours after flame-cutting operations.
   5. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
   6. Dispose of demolished items and materials promptly.

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Removed and Reinstalled Items:
   1. Clean and repair items to functional condition adequate for intended reuse.
   2. Pack or crate items after cleaning and repairing. Identify contents of containers.
   3. Protect items from damage during transport and storage.
   4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.6 CLEANING

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
   1. Do not allow demolished materials to accumulate on-site.
   2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

C. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024119

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, and other pozzolans materials subject to compliance with requirements.

B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.3 ACTION SUBMITTALS

A. Product Data: For each of the following.
   1. Portland cement.
   2. Fly ash.
   3. Slag cement.
   4. Blended hydraulic cement.
   5. Aggregates.
   6. Admixtures:
      a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
   7. Vapor retarders.
   8. Liquid floor treatments.
   9. Curing materials.
   10. Joint fillers.

B. Design Mixtures: For each concrete mixture, include the following:
   1. Mixture identification.
   2. Minimum 28-day compressive strength.
   3. Durability exposure class.
   4. Maximum w/cm.
   5. Calculated equilibrium unit weight, for lightweight concrete.
   6. Slump limit.
   7. Air content.
   8. Nominal maximum aggregate size.

9. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
10. Intended placement method.
11. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Shop Drawings:
1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
a. Location of construction joints is subject to approval of the Architect.

D. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:
1. Concrete Class designation.
2. Location within Project.
3. Exposure Class designation.
4. Formed Surface Finish designation and final finish.
5. Final finish for floors.
6. Curing process.
7. Floor treatment if any.

1.4 INFORMATIONAL SUBMITTALS

A. Preconstruction Test Reports: For each mix design.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.
1. Include the following information in each test report:
a. Admixture dosage rates.
b. Slump.
c. Air content.
d. Seven-day compressive strength.
e. 28-day compressive strength.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and ACI 301.

1.8 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 301 and ACI 306.1.

B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS

A. Cementitious Materials:
   1. Portland Cement: ASTM C150/C150M

B. Normal-Weight Aggregates: ASTM C33/C33M, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.
   1. Alkali-Silica Reaction: Comply with one of the following:
      a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
      b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
      c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. for moderately reactive aggregate or 3 lb./cu. yd. for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301.
   2. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
   3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Air-Entraining Admixture: ASTM C260/C260M.

D. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride in steel-reinforced concrete.
   1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
   2. Retarding Admixture: ASTM C494/C494M, Type B.
   3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
   4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
   5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
   6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

E. Water and Water Used to Make Ice: ASTM C94/C94M, potable

2.3 VAPOR RETARDERS

A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A; not less than 10 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Raven Industries, Inc.
   b. Reef Industries, Inc.
   c. Stego Industries, LLC.
   d. W. R. Meadows, Inc.

2.4 CURING MATERIALS

A. Water: Potable or complying with ASTM C1602/C1602M.

B. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ChemMasters, Inc.
   b. Dayton Superior Corporation.
   c. Euclid Chemical Company (The); an RPM company.

2.5 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork.

2.6 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.
   1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
   1. Fly Ash or Other Pozzolans: 25 percent by mass.
   2. Slag Cement: 50 percent by mass.
   3. Total of Fly Ash or Other Pozzolans, Slag Cement: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass.
   4. Total of Fly Ash or Other Pozzolans: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.
   1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
   2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M, and furnish batch ticket information.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.
   1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
   2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
   3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.
   1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
   3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.2 INSTALLATION OF VAPOR RETARDER

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.
   1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
   2. Face laps away from exposed direction of concrete pour.
   3. Lap vapor retarder over footings and grade beams not less than 6 inches, sealing vapor retarder to concrete.
   4. Lap joints 6 inches and seal with manufacturer's recommended tape.

5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
7. Protect vapor retarder during placement of reinforcement and concrete.
    a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides, and sealing to vapor retarder.

3.3 JOINTS

A. Construct joints true to line, with faces perpendicular to surface plane of concrete.

B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.
1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
2. Place joints perpendicular to main reinforcement.
    a. Continue reinforcement across construction joints unless otherwise indicated.
    b. Do not continue reinforcement through sides of strip placements of floors and slabs.
3. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
4. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

C. Control Joints in Slabs-On-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:
1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

D. Isolation Joints in Slabs-On-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.

2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface, where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints:
1. Install dowel bars and support assemblies at joints where indicated on Drawings.
2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.

F. Dowel Plates: Install dowel plates at joints where indicated on Drawings.

3.4 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.
1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.

B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.

C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete delivery ticket.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not to exceed the amount indicated on the concrete delivery ticket.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.
1. If a section cannot be placed continuously, provide construction joints as indicated.
2. Deposit concrete to avoid segregation.
3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.

4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.
    a. Do not use vibrators to transport concrete inside forms.
    b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
    c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
    d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Do not place concrete floors and slabs in a checkerboard sequence.
2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Maintain reinforcement in position on chairs during concrete placement.
4. Screed slab surfaces with a straightedge and strike off to correct elevations.
5. Level concrete, cut high areas, and fill low areas.
6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.5 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:
1. ACI 301 Surface Finish SF-3.0:
    a. Patch voids larger than 3/4-inch-wide or 1/2 inch deep.
    b. Remove projections larger than 1/8 inch.
    c. Patch tie holes.
    d. Surface Tolerance: ACI 117 Class A.
    e. Locations: Apply to concrete surfaces.

B. Related Unformed Surfaces:
1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces.
2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.6 FINISHING FLOORS AND SLABS

A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Float Finish:
   1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
   2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.
   3. Apply float finish to surfaces to receive trowel finish.

C. Trowel Finish:
   1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
   2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
   3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
   4. Do not add water to concrete surface.
   5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
   6. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
   7. Finish and measure surface, so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inchand also no more than 1/16 inch in 2 feet.

D. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset method. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.
   1. Coordinate required final finish with Architect before application.
   2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.
   1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
   2. Coordinate required final finish with Architect before application.

3.7 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling In:
   1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
   2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
   3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:
   1. Coordinate sizes and locations of concrete bases with actual equipment provided.
   2. Construct concrete bases 4 inches high unless otherwise indicated on Drawings, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
   3. Minimum Compressive Strength: 4000 psi at 28 days.
   4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
   6. Prior to pouring concrete, place and secure anchorage devices.
      a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
      b. Cast anchor-bolt insert into bases.
      c. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items.
   1. Cast-in inserts and accessories, as shown on Drawings.
   2. Screed, tamp, and trowel finish concrete surfaces.

3.8 CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
   1. Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
   2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
   3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h, calculated in accordance with ACI 305.1, before and during finishing operations.

B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:
   1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
   2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
   3. If forms remain during curing period, moist cure after loosening forms.
   4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:
      a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
      b. Continuous Sprinkling: Maintain concrete surface continuously wet.
      c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
      d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
      e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
         1) Recoat areas subject to heavy rainfall within three hours after initial application.
         2) Maintain continuity of coating and repair damage during curing period.

C. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:
   1. Begin curing immediately after finishing concrete.
   2. Interior Concrete Floors:
      a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:
         1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
            a) Lap edges and ends of absorptive cover not less than 12 inches.
            b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
         2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.
            a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
            b) Cure for not less than seven days.
         3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
            a) Water.
            b) Continuous water-fog spray.

b. Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:
    1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
        a) Lap edges and ends of absorptive cover not less than 12 inches.
        b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
    2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.
        a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
        b) Cure for not less than seven days.
    3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
        a) Water.
        b) Continuous water-fog spray.
c. Floors to Receive Polished Finish: Contractor has option of the following:
    1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
        a) Lap edges and ends of absorptive cover not less than 12 inches.
        b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
    2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
        a) Water.
        b) Continuous water-fog spray.
d. Floors to Receive Chemical Stain:
    1) As soon as concrete has sufficient set to permit application without marring concrete surface, install curing paper over entire area of floor.
    2) Install curing paper square to building lines, without wrinkles, and in a single length without end joints.
    3) Butt sides of curing paper tight; do not overlap sides of curing paper.
    4) Leave curing paper in place for duration of curing period, but not less than 28 days.

e. Floors to Receive Urethane Flooring:
   1) As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
   2) Rewet absorptive cover, and cover immediately with polyethylene moisture-retaining cover with edges lapped 6 inches and sealed in place.
   3) Secure polyethylene moisture-retaining cover in place to prohibit air from circulating under polyethylene moisture-retaining cover.
   4) Leave absorptive cover and polyethylene moisture-retaining cover in place for duration of curing period, but not less than 28 days.

f. Floors to Receive Curing Compound:
   1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
   2) Recoat areas subjected to heavy rainfall within three hours after initial application.
   3) Maintain continuity of coating, and repair damage during curing period.
   4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.

g. Floors to Receive Curing and Sealing Compound:
   1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
   2) Recoat areas subjected to heavy rainfall within three hours after initial application.
   3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.9 TOLERANCES

A. Conform to ACI 117.

3.10 APPLICATION OF LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.
   1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
   2. Do not apply to concrete that is less than three days' old.
   3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.
   4. Rinse with water; remove excess material until surface is dry.
   5. Apply a second coat in a similar manner if surface is rough or porous.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller in accordance with manufacturer's written instructions.

3.11 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.

B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
   1. Testing agency to be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
   2. Testing agency to immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
   3. Testing agency shall report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.
      a. Test reports to include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:
         1) Project name.
         2) Name of testing agency.
         3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
         4) Name of concrete manufacturer.
         5) Date and time of inspection, sampling, and field testing.
         6) Date and time of concrete placement.
         7) Location in Work of concrete represented by samples.
         8) Date and time sample was obtained.
         9) Truck and batch ticket numbers.
         10) Design compressive strength at 28 days.
         11) Concrete mixture designation, proportions, and materials.
         12) Field test results.
         13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
         14) Type of fracture and compressive break strengths at seven days and 28 days.

C. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.

D. Inspections:
   1. Headed bolts and studs.
   2. Verification of use of required design mixture.
   3. Concrete placement, including conveying and depositing.
   4. Curing procedures and maintenance of curing temperature.
   5. Verification of concrete strength before removal of shores and forms from beams and slabs.
   6. Batch Plant Inspections: On a random basis, as determined by Architect.

E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M shall be performed in accordance with the following requirements:
   1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
      a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
   2. Slump: ASTM C143/C143M:
      a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
      b. Perform additional tests when concrete consistency appears to change.
   3. Slump Flow: ASTM C1611/C1611M:
      a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
      b. Perform additional tests when concrete consistency appears to change.
   4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete;
      a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   5. Concrete Temperature: ASTM C1064/C1064M:
      a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
   6. Unit Weight: ASTM C567/C567M fresh unit weight of structural lightweight concrete.
      a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
      b. and one set of two specimens at 28 days.
      c. A compressive-strength test to be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
   7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor to evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.
9. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

10. Additional Tests:
    a. Testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
    b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
        1) Acceptance criteria for concrete strength to be in accordance with ACI 301, Section 1.6.6.3.
11. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within 72 hours of completion of floor finishing and promptly report test results to Architect.

3.12 PROTECTION

A. Protect concrete surfaces as follows:
1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.
8. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using Floor Slab Protective Covering.

END OF SECTION 033000

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Concrete masonry units.
   2. Brick.
   3. Mortar and grout materials.
   4. Reinforcement.
   5. Embedded flashing.
   6. Accessories.
   7. Mortar and grout mixes.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 FIELD CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602.

B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602.

PART 2 - PRODUCTS

2.1 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602, except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.
   1. Where fire-resistance-rated construction is indicated.

2.2 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
   1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

B. CMUs: ASTM C90, normal weight.
   1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2800 psi.

2.3 BRICK

A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:
   1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
   2. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

B. Clay Face Brick: Facing brick complying with ASTM C216, Grade SW, Type FBX.
   1. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested in accordance with ASTM C67/C67M.
   2. Efflorescence: Provide brick that has been tested in accordance with ASTM C67/C67M and is rated "not effloresced."
   3. Surface Coating: Brick with colors or textures produced by application of coatings withstand 50 cycles of freezing and thawing in accordance with ASTM C67/C67M with no observable difference in the applied finish when viewed from 10 ft.

2.4 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
   1. Alkali content will not be more than 0.1 percent when tested in accordance with ASTM C114.

B. Hydrated Lime: ASTM C207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Masonry Cement: ASTM C91/C91M.

E. Aggregate for Mortar: ASTM C144.
   1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
   2. For joints less than 1/4-inch-thick, use aggregate graded with 100 percent passing the No. 16 sieve.

F. Aggregate for Grout: ASTM C404.

G. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

H. Water: Potable.

2.5 REINFORCEMENT

A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60.

B. Masonry-Joint Reinforcement, General: ASTM A951/A951M.
   1. Exterior Walls: Hot-dip galvanized carbon steel.
   2. Wire Size for Side Rods: 0.148-inch diameter.
   3. Wire Size for Cross Rods: 0.148-inch diameter.
   4. Wire Size for Veneer Ties: 0.148-inch diameter.
   5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
   6. Provide in lengths of not less than 10 ft.

C. Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods.

D. Masonry-Joint Reinforcement for Multiwythe Masonry:
   1. Ladder type with one side rod at each face shell of hollow masonry units more than 4 inches wide, plus one side rod at each wythe of masonry 4 inches wide or less.
   2. Tab type, either ladder or truss design, with one side rod at each face shell of backing wythe and with rectangular tabs sized to extend at least halfway through facing wythe, but with at least 5/8-inch cover on outside face.
   3. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum horizontal play of 1/16 inch and maximum vertical adjustment of 1-1/4 inches. Size ties to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face. Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe.

2.6 EMBEDDED FLASHING

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
   1. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.016 inch thick.
   2. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 ft. Provide splice plates at joints of formed, smooth metal flashing.
   3. Fabricate metal drip edges from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
   4. Fabricate metal sealant stops from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.

B. Flexible Flashing: Use the following unless otherwise indicated:
   1. Self-Adhering, Stainless Steel Fabric Flashing: Composite, flashing product consisting of 2 mil of Type 304 stainless steel sheet, bonded to a layer of polymeric fabric with a butyl adhesive, to produce an overall thickness of 40 mil.
      a. Applications: Use 10-mil-thick flashing at windows, doors, and small wall penetrations; not at base of walls. Use 40-mil-thick flashing at base of walls.

C. Solder and Sealants for Sheet Metal Flashings: As specified in Section 076200 "Sheet Metal Flashing and Trim."

D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

E. Termination Bars for Flexible Flashing: Aluminum bars 1/8 inch by 1 inch.

F. Termination Bars for Flexible Flashing, Flanged: Stainless steel sheet 0.019 inch by 1-1/2 inches with a 3/8-inch flange at top.

2.7 ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene urethane or PVC.

B. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

C. Weep/Cavity Vents: Use the following unless otherwise indicated:
   1. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from manufacturer's standard.

D. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
   1. Mortar Deflector: Strips, full depth of cavity and 16 inches high, with dovetail-shaped notches that prevent clogging with mortar droppings.

E. Proprietary Acidic Masonry Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

2.8 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
   1. Do not use calcium chloride in mortar or grout.
   2. Use portland cement-lime mortar unless otherwise indicated.
   3. For exterior masonry, use portland cement-lime mortar.
   4. For reinforced masonry, use portland cement-lime mortar.
   5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
   1. For masonry below grade or in contact with earth, use Type M.
   2. For reinforced masonry, use Type M.
   3. For exterior, above-grade, load-bearing, nonload-bearing walls, and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.

D. Grout for Unit Masonry: Comply with ASTM C476.
   1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602 for dimensions of grout spaces and pour height.
   2. Proportion grout in accordance with ASTM C476, Table 1 or paragraph 4.2.1.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
   3. Provide grout with a slump of 8 to 11 inches as measured in accordance with ASTM C143/C143M.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

C. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested in accordance with ASTM C67/C67M. Allow units to absorb water so they are damp but not wet at time of laying.

3.2 TOLERANCES

A. Dimensions and Locations of Elements:
   1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
   2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
   3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:
   1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 ft., or 1/2-inch maximum.
   2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 ft., 1/4 inch in 20 ft., or 1/2-inch maximum.
   3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2-inch maximum.
   4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 ft., 1/4 inch in 20 ft., or 1/2-inch maximum.
   5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., or 1/2-inch maximum.
   6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 ft., or 1/2-inch maximum.

C. Joints:
   1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
   2. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
   3. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.

3.3 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry to match existing; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

D. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

E. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.4 MORTAR BEDDING AND JOINTING

A. Lay CMUs and hollow brick as follows:
   1. Bed face shells in mortar and make head joints of depth equal to bed joints.
   2. Bed webs in mortar in all courses of piers, columns, and pilasters.
   3. Bed webs in mortar in grouted masonry, including starting course on footings.
   4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
   5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Lay structural clay tile as follows:
   1. Lay vertical-cell units with full head joints unless otherwise indicated. Provide bed joints with full mortar coverage on face shells and webs.

   2. Lay horizontal-cell units with full bed joints unless otherwise indicated. Keep drainage channels, if any, free of mortar. Form head joints with sufficient mortar so excess will be squeezed out as units are placed in position. Butter both sides of units to be placed, or butter one side of unit already in place and one side of unit to be placed.
   3. Maintain joint thicknesses indicated except for minor variations required to maintain bond alignment. If not indicated, lay walls with 1/4- to 3/8-inch-thick joints.

D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.5 CAVITY WALLS

A. Bond wythes of cavity walls together using one of the following methods:
   1. Individual Metal Ties: Provide ties as indicated installed in horizontal joints, but not less than one metal tie for 2.67 sq. ft. of wall area spaced not to exceed 16 inches o.c. horizontally and 16 inches o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches o.c. vertically.
   2. Masonry-Joint Reinforcement: Installed in horizontal mortar joints.
      a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes.
      b. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) reinforcement with continuous horizontal wire in facing wythe attached to ties.
      c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable-type (two-piece-type) reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.

B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

C. Installing Cavity Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as indicated.

3.6 MASONRY-JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
   1. Space reinforcement not more than 16 inches o.c.
   2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
   3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

3.7 FLASHING, WEEP HOLES, AND CAVITY VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install cavity vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.

B. Install flashing as follows unless otherwise indicated:
   1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
   2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches, and through inner wythe to within 1/2 inch of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately 2 inches on interior face.
   3. At lintels and shelf angles, extend flashing 6 inches minimum at each end. At heads and sills, extend flashing 6 inches minimum and turn ends up not less than 2 inches to form end dams.
   4. Install metal drip edges with sawtooth sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
   5. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
   6. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.

C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

D. Install weep holes in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.
   1. Use specified weep/cavity vent products to form weep holes.
   2. Space weep holes 24 inches o.c. unless otherwise indicated.
   3. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.

E. Place cavity drainage material in airspace behind veneers to comply with configuration requirements for cavity drainage material in "Accessories" Article.

F. Install cavity vents in head joints in exterior wythes at spacing indicated. Use specified weep/cavity vent products to form cavity vents.
   1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.8 REINFORCED UNIT MASONRY

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
   1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
   2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
   1. Comply with requirements in TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
   2. Limit height of vertical grout pours to not more than 60 inches.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements will be at Contractor's expense.

B. Testing Prior to Construction: One set of tests.

C. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

D. Clay Masonry Unit Test: For each type of unit provided, in accordance with ASTM C67/C67M for compressive strength.

E. Concrete Masonry Unit Test: For each type of unit provided, in accordance with ASTM C140/C140M for compressive strength.

F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, in accordance with ASTM C780.

G. Mortar Test (Property Specification): For each mix provided, in accordance with ASTM C780. Test mortar for mortar air content and compressive strength.

H. Grout Test (Compressive Strength): For each mix provided, in accordance with ASTM C1019.

3.10 CLEANING

A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
   3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
   4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
   5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
   6. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.
   7. Clean masonry with a proprietary acidic masonry cleaner applied according to manufacturer's written instructions.

3.11 MASONRY WASTE DISPOSAL

A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
   1. Do not dispose of masonry waste as fill within 18 inches of finished grade.

B. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Miscellaneous framing and supports.
   2. Shelf angles.

B. Products furnished, but not installed, under this Section include the following:
   1. Loose steel lintels.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Nonslip aggregates and nonslip-aggregate surface finishes.
   2. Shop primers.
   3. Shrinkage-resisting grout.

B. Shop Drawings: Show fabrication and installation details.

PART 2 - PRODUCTS

2.1 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications 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 A36/A36M.

2.2 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

2.3 MISCELLANEOUS MATERIALS

A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
   1. Use primer that contains pigments that make it easily distinguishable from zinc-rich primer.

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

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

D. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.4 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. 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.

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

D. Weld corners and seams continuously to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

E. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

F. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

G. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, not less than 8 inches from ends and corners of units and 24 inches o.c.

2.5 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

2.6 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Galvanize loose steel lintels located in exterior walls.

2.7 GENERAL FINISH REQUIREMENTS

A. Finish metal fabrications after assembly.

2.8 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
   1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

A. Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.3 REPAIRS

A. Touchup Painting:
   1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055000

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Framing with dimension lumber.
   2. Miscellaneous lumber.
   3. Fire-retardant-treated lumber.

1.2 ACTION SUBMITTALS

A. Product Data:
   1. For each type of process and factory-fabricated product.
   2. For preservative-treated wood products.

1.3 INFORMATIONAL SUBMITTALS

A. Material Certificates:
   1. For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
   2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.

B. Evaluation Reports: For the following, from ICC-ES:
   1. Wood-preservative-treated wood.
   2. Fire-retardant-treated wood.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: Comply with DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
   1. Factory mark each piece of lumber with grade stamp of grading agency.
   2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
   3. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content:
   1. Boards: 15 percent.
   2. Dimension Lumber: 15 percent for 2-inch nominal thickness or less; 19 percent for more than 2-inch nominal thickness unless otherwise indicated.

C. Engineered Wood Products: Acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
   1. Allowable design stresses, as published by manufacturer, are to meet or exceed those indicated. Manufacturer's published values are to be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.2 PRESERVATIVE TREATMENT

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
   1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat items indicated on Drawings, and the following:
   1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
   2. Wood sills, sleepers, blocking, furring, and similar concealed members in contact with masonry or concrete.
   3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
   4. Wood framing members that are less than 18 inches above the ground in crawlspaces or unexcavated areas.
   5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATMENT

A. General: Where fire-retardant-treated materials are indicated, materials are to comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Exterior Type: Treated materials are to comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
2. Interior Type A: Treated materials are to have a moisture content of 28 percent or less when tested according to ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.

C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

E. Application: Treat items indicated on Drawings, and the following:
1. Framing for raised platforms.
2. Framing for stages.
3. Concealed blocking.
4. Framing for non-load-bearing partitions.
5. Framing for non-load-bearing exterior walls.
6. Roof construction.
7. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

A. Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
1. Blocking.
2. Nailers.

B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.

C. Concealed Boards: 15 percent maximum moisture content and any of the following species and grades:
1. Mixed southern pine or southern pine; No. 2 grade; SPIB.
2. Eastern softwoods; No. 2 Common grade; NeLMA.

3. Northern species; No. 2 Common grade; NLGA.
4. Western woods; Construction or No. 2 Common grade; WCLIB or WWPA.

2.5 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, A-C, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2-inch nominal thickness.

2.6 FASTENERS

A. General: Fasteners are to be of size and type indicated and comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches into wood substrate.
   1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.

B. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

C. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 ICC-ES AC58 ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate.

2.7 METAL FRAMING ANCHORS

A. Products: Subject to compliance with requirements, provide the following:

   1. MiTek Industries, Inc.;.

B. Allowable design loads, as published by manufacturer, are to meet or exceed those indicated. Manufacturer's published values are to be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency. Framing anchors are to be punched for fasteners adequate to withstand same loads as framing anchors.

C. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M, G60 coating designation.
   1. Use for interior locations unless otherwise indicated.

D. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A653/A653M; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 coating designation; and not less than 0.036 inch thick.
   1. Use for wood-preservative-treated lumber and where indicated.

2.8 MISCELLANEOUS MATERIALS

A. Sill-Sealer Gaskets:
   1. Glass-fiber-resilient insulation, fabricated in strip form, for use as a sill sealer; 1-inch nominal thickness, compressible to 1/32 inch; selected from manufacturer's standard widths to suit width of sill members indicated.
   2. Closed-cell neoprene foam, 1/4-inch-thick, selected from manufacturer's standard widths to suit width of sill members indicated.

3. Self-adhering sheet consisting of 64mils of rubberized asphalt laminated on one side to a 4-mil-thick, polyethylene-film reinforcement, and with release liner on adhesive side; formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.

B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch.

C. Adhesives for Gluing Furring to Concrete or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

B. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.

C. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.

D. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

E. Do not splice structural members between supports unless otherwise indicated.

F. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

G. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

H. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code (IBC).
2. ICC-ES evaluation report for fastener.

3.2 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061000

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Manufactured reglets with counterflashing.
   2. Formed low-slope roof sheet metal fabrications.
   3. Formed wall sheet metal fabrications.

1.2 ACTION SUBMITTALS

A. Product Data: For each of the following
   1. Underlayment materials.
   2. Elastomeric sealant.
   3. Butyl sealant.

B. Shop Drawings: For sheet metal flashing and trim.
   1. Include plans, elevations, sections, and attachment details.
   2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
   3. Include identification of material, thickness, weight, and finish for each item and location in Project.
   4. Include details for forming, including profiles, shapes, seams, and dimensions.
   5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
   6. Include details of termination points and assemblies.
   7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
   8. Include details of roof-penetration flashing.
   9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
   10. Include details of special conditions.
   11. Include details of connections to adjoining work.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

B. Special warranty.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
   1. For copings and roof edge flashings that are ANSI/SPRI/FM 4435/ES-1 tested, shop is to be listed as able to fabricate required details as tested and approved.

1.5 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
      b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SHEET METALS

A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Stainless Steel Sheet: ASTM A240/A240M, Type 304, dead soft, fully annealed; with smooth, flat surface.
   1. Finish: ASTM A480/A480M, No. 2D (dull, cold rolled).

2.3 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet Underlayment: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer in accordance with underlayment manufacturer's written instructions.
   1. Low-Temperature Flexibility: ASTM D1970/D1970M; passes after testing at minus 20 deg F or lower.

B. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. minimum.

2.4 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal.
   1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
      a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
      b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
      c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
   2. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.

C. solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2-inch-wide and 1/8 inch thick.

D. Elastomeric Sealant: ASTM C920, elastomeric polyurethane polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

F. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.

G. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

H. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions.
   1. Material: Stainless steel, 0.0188 inch thick.
   2. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
   3. Accessories:
      a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
      b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge.
   4. Finish: Mill.

2.5 FABRICATION, GENERAL

A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
   1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
   2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
   3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
   4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
   5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances:
   1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
   2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.

C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
   1. Form expansion joints of intermeshing hooked flanges, not less than 1-inch-deep, filled with butyl sealant concealed within joints.
   2. Use lapped expansion joints only where indicated on Drawings.

D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Seams:
   1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
   2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
   3. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.

2.6 WALL SHEET METAL FABRICATIONS

A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch-long, but not exceeding 12-foot-long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings; and form with 2-inch-high, end dams. Fabricate from the following materials:
   1. Stainless Steel: 0.0156 inch thick.

PART 3 - EXECUTION

3.1 INSTALLATION OF UNDERLAYMENT

A. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim.
   1. Install in shingle fashion to shed water.
   2. Lap joints not less than 2 inches.

B. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, in accordance with manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.
   1. Lap horizontal joints not less than 4 inches.
   2. Lap end joints not less than 12 inches.

C. Self-Adhering, High-Temperature Sheet Underlayment:
   1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
   2. Prime substrate if recommended by underlayment manufacturer.
   3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
   4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses.
   5. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller.
   6. Roll laps and edges with roller.
   7. Cover underlayment within 14 days.

3.2 INSTALLATION, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.
   1. Install fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
   2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of sealant.
   3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
   4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
   5. Install continuous cleats with fasteners spaced not more than 12 inches o.c.
   6. Space individual cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
   7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
   8. Do not field cut sheet metal flashing and trim by torch.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
   1. Coat concealed side of stainless steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
   2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
   1. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
   2. Form expansion joints of intermeshing hooked flanges, not less than 1-inch-deep, filled with sealant concealed within joints.
   3. Use lapped expansion joints only where indicated on Drawings.

D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction.
   1. Use sealant-filled joints unless otherwise indicated.
      a. Embed hooked flanges of joint members not less than 1 inch into sealant.
      b. Form joints to completely conceal sealant.
      c. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
      d. Adjust setting proportionately for installation at higher ambient temperatures.
         1) Do not install sealant-type joints at temperatures below 40 deg F.
   2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.3 INSTALLATION OF ROOF FLASHINGS

A. Install sheet metal flashing and trim to comply with performance requirements and cited sheet metal standard.
   1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
   2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.
   1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
   2. Extend counterflashing 4 inches over base flashing.
   3. Lap counterflashing joints minimum of 4 inches.

3.4 INSTALLATION OF WALL FLASHINGS

A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

3.5 INSTALLATION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.6 CLEANING

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder.

C. Clean off excess sealants.

3.7 PROTECTION

A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 076200

SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Roof curbs.
   2. Equipment supports.
   3. Pipe and duct supports.
   4. Pipe portals.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of roof accessory.

B. Shop Drawings: For roof accessories.

C. Samples: For each exposed product and for each color and texture specified.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ROOF CURBS

A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, straight sides, and integrally formed deck-mounting flange at perimeter bottom.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AES Industries, Inc.
      b. Air Balance; a division of MESTEK, Inc.
      c. Curbs Plus, Inc.
      d. Greenheck Fan Corporation.
      e. LMCurbs.

f. Pate Company (The).
g. Roof Products, Inc.
h. Thybar Corporation.

B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

C. Material: Zinc-coated (galvanized) steel sheet, 0.052 inch thick.
1. Finish: Baked enamel or powder coat.
2. Color: As selected by Architect from manufacturer's full range.

D. Material: Stainless steel sheet, 0.0781 inch thick.
1. Finish: Manufacturer's standard.

E. Construction:
1. Curb Profile: Manufacturer's standard compatible with roofing system.
2. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
3. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
4. Top Surface: Level top of curb, with roof slope accommodated by sloping deck-mounting flange.
5. Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.
6. Insulation: Factory insulated with 1-1/2-inch- thick glass-fiber board insulation.
7. Liner: Same material as curb, of manufacturer's standard thickness and finish.
8. Nailer: Factory-installed wood nailer along top flange of curb, continuous around curb perimeter.
9. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.
10. Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from 3/4-inch-thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
11. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.
12. Damper Tray: Provide damper tray or shelf with opening 3 inches.

2.2 EQUIPMENT SUPPORTS

A. Equipment Supports: Rail-type metal equipment supports capable of supporting superimposed live and dead loads between structural supports, including equipment loads and other construction indicated on Drawings, spanning between structural supports; capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, and integrally formed structure-mounting flange at bottom.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AES Industries, Inc.
   b. Air Balance; a division of MESTEK, Inc.
   c. Curbs Plus, Inc.
   d. Greenheck Fan Corporation.
   e. LMCurbs.
   f. Pate Company (The).
   g. Roof Curb Systems.
   h. Thybar Corporation.

B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

C. Material: Zinc-coated (galvanized) steel sheet, 0.052 inch thick.
   1. Finish: Baked enamel or powder coat.
   2. Color: As selected by Architect from manufacturer's full range.

D. Material: Stainless steel sheet, 0.0781 inch thick.
   1. Finish: Manufacturer's standard.

E. Construction:
   1. Curb Profile: Manufacturer's standard compatible with roofing system.
   2. Liner: Same material as equipment support, of manufacturer's standard thickness and finish.
   3. Nailer: Factory-installed continuous wood nailers 3-1/2 inches wide on top flange of equipment supports, continuous around support perimeter.
   4. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb of size and spacing required to meet wind uplift requirements.
   5. Platform Cap: Where portion of equipment support is not covered by equipment, provide weathertight platform cap formed from 3/4-inch-thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
   6. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
   7. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
   8. Fabricate equipment supports to minimum height of 12 inches above roofing surface unless otherwise indicated.
   9. Sloping Roofs: Where roof slope exceeds 1:48, fabricate each support with height to accommodate roof slope so that tops of supports are level with each other. Equip supports with water diverters or crickets on sides that obstruct water flow.

2.3 PIPE AND DUCT SUPPORTS

A. Fixed-Height Cradle-Type Pipe Supports: Polycarbonate pipe stand accommodating up to 1-1/2-inch- (38-mm-) diameter pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.

B. Fixed-Height Roller-Bearing Pipe Supports: Polycarbonate pipe stand with polycarbonate roller carrying assembly accommodating up to 7-inch- (178-mm-) diameter pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.

C. Adjustable-Height Roller-Bearing Pipe Supports: Polycarbonate pipe stand base, pipe support, and roller housing, with stainless steel threaded rod designed for adjusting support height, accommodating up to 18 inch (457 mm) diameter pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.

2.4 PIPE PORTALS

A. Flashing Pipe Portal: Formed aluminum membrane-mounting flashing flange and sleeve with collared opening and pressure-sealed conically shaped EPDM protective rubber cap sized for piping indicated, with stainless steel snaplock swivel clamps.

2.5 METAL MATERIALS

A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 coating designation.
   1. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
   2. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.
   3. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.
   4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

B. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, AZ50 coated.
   1. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
   2. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.
   3. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.
   4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

C. Aluminum Extrusions and Tubes: ASTM B221, manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.

D. Stainless Steel Sheet and Shapes: ASTM A240/A240M or ASTM A666, Type 304.

E. Steel Shapes: ASTM A36/A36M, hot-dip galvanized according to ASTM A123/A123M unless otherwise indicated.

F. Steel Tube: ASTM A500**/**A500M, round tube.

G. Galvanized-Steel Tube: ASTM A500**/**A500M, round tube, hot-dip galvanized according to ASTM A123/A123M.

H. Steel Pipe: ASTM A53/A53M, galvanized.

2.6 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.

C. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches thick.

D. Underlayment:
   1. Felt: ASTM D226**/**D226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
   2. Polyethylene Sheet: 6-mil-thick polyethylene sheet complying with ASTM D4397.
   3. Slip Sheet: Building paper, 3 lb/100 sq. ft. minimum, rosin sized.

4. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

E. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:

F. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

G. Elastomeric Sealant: ASTM C920, elastomeric polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

H. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

I. Asphalt Roofing Cement: ASTM D4586**/**D4586M, asbestos free, of consistency required for application.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify dimensions of roof openings for roof accessories. Install roof accessories according to manufacturer's written instructions.
1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.

C. Pipe Support Installation: Comply with MSS SP-58 and MSS SP-89. Install supports and attachments as required to properly support piping. Arrange for grouping of parallel runs of horizontal piping, and support together.

1. Pipes of Various Sizes: Space supports for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

D. Preformed Flashing-Sleeve and Flashing-Pipe Portal Installation: Secure flashing sleeve to roof membrane according to flashing-sleeve manufacturer's written instructions; flash sleeve flange to surrounding roof membrane according to roof membrane manufacturer's instructions.

E. Seal joints with butyl sealant as required by roof accessory manufacturer.

3.2 REPAIR AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A780**/**A780M.

B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 099113 "Exterior Painting."

C. Clean exposed surfaces according to manufacturer's written instructions.

D. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Penetrations in fire-resistance-rated walls.

1.2 ACTION SUBMITTALS

A. Product data.

B. Sustainable Design Submittals:
   1. Product Data: For sealants, indicating VOC content.
   2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.
   1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines. Obtain approval of authorities having jurisdiction prior to submittal.

1.3 INFORMATIONAL SUBMITTALS

A. Listed system designs.

1.4 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:
   1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
   2. Test in accordance with testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:
      a. Penetration firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with listed system designs published by a qualified testing agency.
         1) UL in its online directory "Product iQ."
         2) Intertek Group in its "Directory of Building Products."
         3) FM Approvals in its "Approval Guide."

2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Description: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems are to be compatible with one another, with the substrates forming openings, and with penetrating items if any.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. 3M Building and Construction.
      b. Hilti, Inc.
      c. Passive Fire Protection Partners.
      d. Specified Technologies, Inc.
      e. Tremco Incorporated.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined in accordance with ASTM E814 or UL 1479.
   1. F-Rating: Not less than the fire-resistance rating of the wall penetrated.
   2. Membrane Penetrations: Install recessed fixtures such that the required fire resistance will not be reduced.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined in accordance with ASTM E814 or UL 1479.
   1. F-Rating: At least one hour, but not less than the fire-resistance rating of the floor penetrated.

2. T-Rating: At least one hour, but not less than the fire-resistance rating of the floor. The following floor penetrations do not require a T-rating:
   a. Those within the cavity of a wall.
   b. Floor, tub, or shower drains within a concealed space.
   c. 4-inch or smaller metal conduit penetrating directly into metal-enclosed electrical switchgear.
3. W-Rating: Provide penetration firestopping systems with a Class 1 W-rating in accordance with UL 1479.

D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined in accordance with UL 1479.
   1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.

E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, in accordance with ASTM E84.
   1. Verify sealant has a VOC content of 250 g/L or less.

F. 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 system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

PART 3 - EXECUTION

3.1 INSTALLATION OF PENETRATION FIRESTOPPING SYSTEMS

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. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

C. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
   1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

D. Install fill materials by proven techniques to produce the following results:
   1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
   2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
   3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.2 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.
   1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
   1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
   2. Contractor's name, address, and phone number.
   3. Designation of applicable testing and inspecting agency.
   4. Date of installation.
   5. Manufacturer's name.
   6. Installer's name.

3.3 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

END OF SECTION 078413

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Silicone joint sealants.
   2. Nonstaining silicone joint sealants.
   3. Urethane joint sealants.
   4. Latex joint sealants.

1.2 ACTION SUBMITTALS

A. Product data.

B. Samples: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Joint-sealant schedule.

1.3 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports: For field-adhesion-test reports, for each sealant application tested.

B. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Warranty Documentation:
   1. Manufacturers' special warranties.
   2. Installer's special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified in accordance with ASTM C1021 to conduct the testing indicated.

1.6 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
   1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
   2. Disintegration of joint substrates from causes exceeding design specifications.
   3. Mechanical damage caused by individuals, tools, or other outside agents.
   4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

A. Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Adfast.
      b. GE Construction Sealants; Momentive Performance Materials Inc.
      c. Sika Corporation - Building Components.

2.3 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested in accordance with ASTM C1248.

B. Silicone, Nonstaining, S, NS, 100/50, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Adfast.
      b. Pecora Corporation.
      c. Sika Corporation - Building Components.
      d. Tremco Incorporated.

2.4 URETHANE JOINT SEALANTS

A. Urethane, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Bostik; Arkema.
      b. Master Builders Solutions.
      c. Pecora Corporation.
      d. Polymeric Systems, Inc.
      e. Sherwin-Williams Company (The).
      f. Sika Corporation - Building Components.
      g. Tremco Incorporated.

2.5 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Everkem Diversified Products, Inc.
      b. Pecora Corporation.
      c. Sherwin-Williams Company (The).
      d. Tremco Incorporated.

2.6 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Alcot Plastics Ltd.
b. Construction Foam Products; a division of Nomaco, Inc.
c. Master Builders Solutions.

B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin) Type O (open-cell material) Type B (bicellular material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.7 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
   1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
   2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
      a. Concrete.
      b. Masonry.
      c. Unglazed surfaces of ceramic tile.
      d. Exterior insulation and finish systems.
   3. Remove laitance and form-release agents from concrete.

4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
   a. Metal.
   b. Glass.
   c. Porcelain enamel.
   d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.2 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.
   3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants in accordance with requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.
   4. Provide flush joint profile at in accordance with Figure 8B in ASTM C1193.

   5. Provide recessed joint configuration of recess depth and at locations indicated on Drawings in accordance with Figure 8C in ASTM C1193.
      a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

G. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

H. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 079200

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Framing systems.
   2. Suspension systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each product.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of code-compliance certification for studs and tracks.

1.4 QUALITY ASSURANCE

A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association the Steel Framing Industry Association the Steel Stud Manufacturers Association or the Supreme Steel Framing System Association.

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, in accordance with ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, in accordance with ASTM E90 and classified in accordance with ASTM E413 by an independent testing agency.

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C645 for conditions indicated.
   1. Steel Sheet Components: Comply with ASTM C645 requirements for metal unless otherwise indicated

   2. Protective Coating: Comply with ASTM C645; ASTM A653/A653M, G40; or coating with equivalent corrosion resistance. Galvannealed products are unacceptable.
      a. Coating demonstrates equivalent corrosion resistance with an evaluation report acceptable to authorities having jurisdiction.

B. Studs and Track: ASTM C645.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ClarkDietrich.
      b. Marino\WARE.
      c. Steel Network, Inc. (The).
      d. Telling Industries.
   2. Minimum Base-Steel Thickness: As required by performance requirements for horizontal deflection.
   3. Depth: As indicated on Drawings.

C. Hat-Shaped, Rigid Furring Channels:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ClarkDietrich.
      b. Jaimes Industries.
      c. Marino\WARE.
      d. Steel Construction Systems; Stone Group of Companies.

   2. Minimum Base-Steel Thickness: 0.0296 inch.
   3. Depth: As indicated on Drawings.

D. Resilient Furring Channels: 1/2-inch-deep, steel sheet members designed to reduce sound transmission.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ClarkDietrich.
      b. Marino\WARE.
      c. Steel Construction Systems; Stone Group of Companies.

   2. Configuration: Asymmetrical.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.

B. Hanger Attachments to Concrete:
   1. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 AC193 AC58 or AC308 as appropriate for the substrate.
      a. Uses: Securing hangers to structure.
      b. Type: Torque-controlled, expansion anchor.
      c. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
      d. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel bolts, ASTM F593, and nuts, ASTM F594.

C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

D. Flat Hangers: Steel sheet, 1 by 3/16 inch by length indicated.

E. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch and minimum 1/2-inch-wide flanges.
   1. Depth: 2-1/2 inches.

F. 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 Tracks: Use either conventional steel studs and tracks or embossed, high-strength steel studs and tracks.
      a. Minimum Base-Steel Thickness: 0.0190 inch.
      b. Depth: As indicated on Drawings.
   3. Hat-Shaped, Rigid Furring Channels: 7/8 inch deep.
      a. Minimum Base-Steel Thickness: 0.0296 inch.
   4. Resilient Furring Channels: 1/2-inch-deep members designed to reduce sound transmission.
      a. Configuration: Asymmetrical.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.
   1. Fasteners for Steel 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 D226/D226M, 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 INSTALLATION, GENERAL

A. Installation Standard: ASTM C754.
   1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C841 that apply to framing installation.
   2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C1063 that apply to framing installation.
   3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C844 that apply to framing installation.
   4. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 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.

3.2 INSTALLATION OF FRAMING SYSTEMS

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks 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 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.
      a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
   5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
   6. Curved Partitions:
      a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
      b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches o.c.

E. Direct Furring:
   1. Screw to wood framing.
   2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

F. 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.
   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.

G. 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.

3.3 INSTALLATION OF SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
      a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
   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. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
   5. Do not attach hangers to steel roof deck.
   6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
   7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
   8. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

3.4 FIELD QUALITY CONTROL

A. 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 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Interior gypsum board.

1.2 ACTION SUBMITTALS

A. Product data.

B. Shop Drawings: Show locations and installation of control and expansion joints, including plans, elevations, sections, details of components, and attachments to other work.

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 in accordance with ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated in accordance with ASTM E90 and classified in accordance with ASTM E413 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. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Gypsum.
      b. CertainTeed; SAINT-GOBAIN.
      c. Continental Building Products Inc.
      d. Georgia-Pacific Gypsum LLC.
      e. USG Corporation.

2. Core: 5/8 inch, Type X.
3. Long Edges: Tapered.
4. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

2.4 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047.
   1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
   2. Shapes:
      a. Cornerbead.
      b. Bullnose bead.
      c. LC-Bead: J-shaped; exposed long flange receives joint compound.
      d. L-Bead: L-shaped; exposed long flange receives joint compound.
      e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
      f. Expansion (control) joint.
      g. Curved-Edge Cornerbead: With notched or flexible flanges.

2.5 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M.

B. Joint Tape:
   1. Interior Gypsum Board: Paper.
   2. Exterior Gypsum Soffit Board: Paper.
   3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
   4. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
   1. Prefilling: At open joints 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 setting-type, sandable topping compound.
   5. Skim Coat: For final coat of Level 5 finish, use high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.

D. Joint Compound for Exterior Applications:
   1. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.
   2. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.

2.6 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
   1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
   2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

D. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
   1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

E. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

F. Vapor Retarder: As specified in Section 072600 "Vapor Retarders."

PART 3 - EXECUTION

3.1 INSTALLATION OF PANELS

A. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

B. Comply with ASTM C840.

C. 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.

D. 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.

3.2 FINISHING OF GYPSUM BOARD

A. Prefill open joints and damaged surface areas.

B. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

C. Gypsum Board Finish Levels: Finish panels to levels indicated below and in accordance with ASTM C840:
   1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
   2. Level 2: Panels that are substrate for tile.
   3. Level 3: Where indicated on Drawings.
   4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
      a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
   5. Level 5: Where indicated on Drawings.
      a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

3.3 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

END OF SECTION 092900

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Thermoplastic-rubber base.
   2. Rubber molding accessories.

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.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC-RUBBER BASE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong Flooring, Inc.
   2. Johnsonite; a Tarkett company.
   3. Roppe Corporation.
   4. VPI Corporation.

B. Product Standard: ASTM F1861, Type TP (rubber, thermoplastic).
   1. Group: I (solid, homogeneous).
   2. Style and Location:
      a. Style B, Cove

C. Thickness: 0.125 inch.

D. Height: Match existing.

E. Lengths: Coils in manufacturer's standard length.

F. Outside Corners: Job formed.

G. Inside Corners: Job formed.

H. Colors: Match existing.

2.2 RUBBER MOLDING ACCESSORY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Roppe Corporation.
   2. VPI Corporation.

B. Description: Rubber transition strips.

C. Profile and Dimensions: Match existing.

D. Colors and Patterns: Match existing.

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. Verify adhesives have a VOC content of 50 g/L or less.

C. Stair-Tread Nose Filler: Two-part epoxy compound recommended by resilient stair-tread manufacturer to fill nosing substrates that do not conform to tread contours.

D. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient stair-tread manufacturer.

PART 3 - EXECUTION

3.1 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 materials are the same temperature as space where they are to be installed.

D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.2 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. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

H. 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.
      a. Miter or cope corners to minimize open joints.

3.3 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Stair Accessories:
   1. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
   2. Tightly adhere to substrates throughout length of each piece.
   3. For treads installed as separate, equal-length units, install to produce a flush joint between units.

C. 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.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513

SECTION 096519 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Vinyl composition floor tile.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and pattern specified.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For resilient floor tile, as determined by testing identical products according to ASTM E648 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong Flooring, Inc.
   2. Armstrong World Industries, Inc.
   3. Congoleum Flooring.
   4. Johnsonite; a Tarkett company.

B. Tile Standard: ASTM F1066.

C. Wearing Surface: Smooth.

D. Thickness: 0.125 inch.

E. Size: 12 by 12 inches.

F. Colors and Patterns: Match existings.

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. Verify adhesives have a VOC content of 50 g/L or less.

C. Floor Polish: Provide protective, liquid floor-polish products recommended by floor tile manufacturer.

PART 3 - EXECUTION

3.1 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 F710.
   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, but not less than 5 or more than 9 pH.
   4. Moisture Testing: Perform tests so that each test area does not exceed 1000 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 F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

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 materials are the same temperature as 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.

3.2 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 in pattern to match existing.

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 in pattern of colors and sizes to match existing.

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 installation 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 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.

I. Floor Polish: Remove soil, adhesive, and blemishes from floor tile surfaces before applying liquid floor polish.
   1. Apply three coat(s).

END OF SECTION 096519

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Primers.
   2. Water-based finish coatings.
   3. Dry fall coatings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of topcoat product.

C. Product Schedule: Use same designations indicated on Drawings and in the Interior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Benjamin Moore & Co.
   2. Dulux Canada; a licensed product of PPG Architectural Coatings.
   3. Sherwin-Williams Company (The).

2.2 PAINT PRODUCTS, GENERAL

A. Material Compatibility:
   1. Materials for use within each paint system shall be 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, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

B. VOC Content: For field applications that are inside the weatherproofing system, verify paints and coatings comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
   1. Flat Paints and Coatings: 50 g/L.
   2. Nonflat Paints and Coatings: 150 g/L.
   3. Dry-Fog Coatings: 400 g/L.
   4. Primers, Sealers, and Undercoaters: 200 g/L.
   5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
   6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
   7. Pretreatment Wash Primers: 420 g/L.
   8. Shellacs, Clear: 730 g/L.
   9. Shellacs, Pigmented: 550 g/L.

C. Low-Emitting Materials: Verify interior paints and coatings comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Colors: Match Architect's samples. Match existing.
   1. Twenty percent of surface area will be painted with deep tones.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

B. 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 applicable to substrates and paint systems 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.

C. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

3.3 INSTALLATION

A. Apply paints according to manufacturer's written instructions.

B. 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.

C. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
   1. Paint the following work where exposed in equipment rooms:
      a. Equipment, including panelboards.
      b. Uninsulated metal piping.
      c. Uninsulated plastic piping.
      d. Pipe hangers and supports.
      e. Metal conduit.
      f. Plastic conduit.
      g. Tanks that do not have factory-applied final finishes.
      h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
   2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 CLEANING AND PROTECTION

A. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

B. 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.

C. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 INTERIOR PAINTING SCHEDULE

A. CMU Substrates:
   1. Latex System:
      a. Block Filler: Interior/exterior latex block filler.
      b. Intermediate Coat: Matching topcoat.
      c. Topcoat: Interior, latex, eggshell.

B. Steel Substrates:
   1. Latex System, Alkyd Primer:
      a. Prime Coat: Alkyd quick-dry primer for metal.
      b. Intermediate Coat: Matching topcoat.
      c. Topcoat: Interior, latex, semigloss.

2. Latex over Shop-Applied Quick-Drying Shop Primer System:
    a. Prime Coat: Quick-dry primer for shop application.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, latex, semigloss.

C. Galvanized-Metal Substrates:
1. Latex System Insert drawing designation:
    a. Prime Coat: Water-based galvanized primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, latex, semigloss.

D. Gypsum Board and Plaster Substrates:
1. Latex over Latex Sealer System:
    a. Prime Coat: Interior latex primer sealer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, latex, eggshell.
2. Latex over Alkyd Primer System (for Plaster Only):
    a. Prime Coat: Interior alkyd primer sealer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, latex, eggshell.

E. Cotton or Canvas and ASJ Insulation-Covering Substrates: Including pipe and duct coverings.
1. Latex System:
    a. Prime Coat: Interior latex primer sealer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, latex, flat.

END OF SECTION 099123

SECTION 123216 - MANUFACTURED PLASTIC-LAMINATE-CLAD CASEWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Plastic-laminate-clad casework.
   2. Hardware and accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For plastic-laminate-clad casework.

C. Samples: For casework and hardware finishes.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of casework that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CASEWORK

A. Quality Standard: Unless otherwise indicated, comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards" for grades of casework indicated for construction, finishes, installation, and other requirements.
   1. Grade: Premium.

B. Product Designations:
   1. Drawings indicate sizes, configurations, and finish materials of manufactured plastic-laminate-clad casework by referencing designated manufacturer's catalog numbers. Other manufacturers' casework of similar sizes and door and drawer configurations, of same finish materials, and complying with the Specifications may be considered. See Section 016000 "Product Requirements."

2. Drawings indicate configurations of manufactured plastic-laminate-clad casework by referencing designations of Casework Design Series numbering system in the Appendix of the AWI/AWMAC/WI's "Architectural Woodwork Standards."

2.2 PLASTIC-LAMINATED-FACED CABINETS

A. Design: Frameless cabinet construction with the following door and drawer-front style:
   1. Flush overlay.

B. Grain Direction for Wood-Grain Plastic Laminate:
   1. Doors: Vertical with continuous vertical matching.
   2. Drawer Fronts: Vertical with continuous vertical matching.
   3. Face Frame Members: Lengthwise.
   4. End Panels: Vertical.
   5. Bottoms and Tops of Units: Side to side.
   6. Knee Space Panels: Vertical.
   7. Aprons: Horizontal.

C. Exposed Materials:
   1. Plastic-Laminate Grade: HGS.
      a. Colors and Patterns: As selected by Architect from manufacturer's full range.
   2. Edgebanding: PVC.
      a. PVC Edgebanding Color: As selected by Architect from casework manufacturer's full range.

D. Semiexposed Materials:
   1. Plastic Laminate: Grade VGS unless otherwise indicated. Provide plastic laminate for semiexposed surfaces unless otherwise indicated.
      a. Colors and Patterns: As selected by Architect from manufacturer's full range.
      b. Provide plastic laminate of same grade as exposed surfaces for interior faces of doors and drawer fronts and other locations where opposite side of component is exposed.
   2. Thermally Fused Laminate (TFL) Panels: Provide thermally fused laminate panels for semiexposed surfaces unless otherwise indicated.
      a. Colors and Patterns: As selected by Architect from manufacturer's full range.
      b. Provide plastic laminate of same grade as exposed surfaces for interior faces of doors and drawer fronts and other locations where opposite side of component is exposed.
   3. Hardboard: Use only for cabinet backs where exterior side of back is not exposed.
   4. Metal for Steel Drawer Pans: Cold-rolled, carbon-steel sheet complying with ASTM A1008/A1008M; matte finish; suitable for exposed applications.
   5. Unless otherwise indicated, provide specified edgebanding on all semiexposed edges.

E. Concealed Materials:
   1. Plywood: Hardwood plywood.
   2. Plastic Laminate: Grade VGS.
   3. Particleboard.
   4. MDF.

2.3 MATERIALS

A. Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.

B. Hardwood Plywood: HPVA HP-1, particleboard core except where veneer core is indicated.

C. Softwood Plywood: DOC PS 1.

D. Particleboard: ANSI A208.1, Grade M-2.

E. MDF: Medium-density fiberboard, ANSI A208.2, Grade 130.

F. Plastic Laminate: High-pressure decorative laminate complying with ISO 4586-3.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Formica Corporation.
      b. Nevamar Company, LLC.
      c. Pionite; a Panolam Industries International, Inc. brand.
      d. Wilsonart LLC.

G. PVC Edgebanding for Plastic Laminate: Rigid PVC extrusions, through color with satin finish, 3.0 mm thick at doors and drawer fronts, 1.0 mm thick elsewhere.

H. Thermally Fused Laminate (TFL) Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper.
   1. Edgebanding for Thermally Fused Laminate (TFL) Panels: PVC or polyester edgebanding matching thermally fused laminate panels.

2.4 HARDWARE AND ACCESSORIES

A. Hardware, General: Unless otherwise indicated, provide manufacturer's standard satin-finish, commercial-quality, heavy-duty hardware.
   1. Use threaded metal or plastic inserts with machine screws for fastening to particleboard except where hardware is through-bolted from back side.

B. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, Type B01602, self-closing.

C. Door and Drawer Bumpers: Self-adhering, clear silicone rubber.

D. Drawer Slides: Manufacturer's standard; complying with ANSI/BHMA A156.9.

E. Adjustable Shelf Supports:
   1. Adjustable Shelf Supports: Pin-type, two-pin-locking plastic shelf rests complying with ANSI/BHMA A156.9, Type B04013.
   2. Adjustable Shelf Supports: Mortise-type, zinc-plated steel standards and shelf rests complying with ANSI/BHMA A156.9, Type B04071 and Type B04091.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Grade: Install casework to comply with same quality standard grade as item to be installed.

B. Install casework level, plumb, and true in line; shim as required using concealed shims. Where casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.

C. Base Cabinets: Set cabinets straight, level, and plumb. Adjust subtops within 1/16 inch of a single plane. Align similar adjoining doors and drawers to a tolerance of 1/16 inch. Bolt adjacent cabinets together with joints flush, tight, and uniform.

D. Wall Cabinets: Hang cabinets straight, level, and plumb. Adjust fronts and bottoms within 1/16 inch of a single plane. Fasten cabinets to hanging strips, masonry, framing, wood blocking, or reinforcements in walls and partitions. Align similar adjoining doors to a tolerance of 1/16 inch.

E. Fasten casework to adjacent units and to masonry, framing, wood blocking, or reinforcements in walls and partitions to comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards."

F. Install hardware uniformly and precisely. Set hinges snug and flat in mortises unless otherwise indicated. Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final adjustment after installation.

G. Adjust operating hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

H. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

END OF SECTION 123216

SECTION 230500 - COMMON WORK RESULTS FOR MECHANICAL

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. Division 23, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 013100 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.

1.2 SUMMARY

A. This Section includes the following:
1. Piping materials and installation instructions common to most piping systems.
2. Access Doors.
3. Transition fittings.
4. Dielectric fittings.
5. Mechanical sleeve seals.
6. Sleeves.
7. Escutcheons.
8. Grout.
9. Mechanical Demolition.
10. Equipment installation requirements common to equipment sections.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, 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.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for materials:
   1. ABS: Acrylonitrile-butadiene-styrene plastic.
   2. CPVC: Chlorinated polyvinyl chloride plastic.
   3. PE: Polyethylene plastic.
   4. PVC: Polyvinyl chloride plastic.
   5. EPDM: Ethylene-propylene-diene terpolymer rubber.
   6. NBR: Acrylonitrile-butadiene rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Escutcheons.

B. Sustainable Design Submittals:
   1. Product Data: For sealants, indicating VOC content.
   2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 SUBMITTALS

A. Welding certificates.

B. Shop drawings: Submit for all major equipment including, but not limited to the items listed in Division 20, 22, 23. Submittals shall be provided in electronic format.

C. As-built Drawings: Submit as-built drawings that include accurate dimensioned record drawings of all underground work, above ground piping, and ductwork systems. As-built drawings shall be submitted in electronic format.

D. Operation and Maintenance Manuals: When the building is substantially complete and before the building is taken over by the Owner for maintenance purposes, the contractor shall provide four sets of complete operation and maintenance manuals. The manual shall consist of an indexed loose-leaf binder containing the equipment data, manufacturer's installation, operating, and maintenance, repair parts manual for each system component, test reports, and as-built temperature control diagrams. Refer to Divisions 20, 21, 22, and 23 for additional submittal requirements. Provide an electronic copy of the operation and maintenance manual in addition to three (3) sets of loose-leaf hard copy binders. Preliminary copy of O&M manuals shall be submitted to commissioning agent for review. Schedule of preliminary submittal will be reviewed with Commissioning Agent at the commissioning kick off meeting.

E. Substitutions: The contractors' base bid must be in accordance with the materials or products specified. Any exceptions to this must be approved in writing by the Architect/Engineer, 10 days or more prior to bidding. Voluntary alternates may be submitted for consideration on the proposal, with listed addition or deductions to the base bid, but will not affect the awarding of the contract.

1.7 QUALITY ASSURANCE

A. Codes and Standards: Perform all Work in accordance with applicable Federal, State and local codes rules, ordinances and regulations. The electrical and physical properties of all materials, and the design, performance characteristics, and methods of construction of all items of equipment, shall be in accordance with the latest issue of the various, applicable Standards, Rules and Regulations of NFPA, UL, and as follows unless otherwise indicated.
   1. ASHRAE 55
   2. ASHRAE 62.1
   3. ASHRAE 90.1

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. Electrical Characteristics for Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

E. Permits and inspections: Obtain and pay for all permits (temporary and permanent), fees, and inspections as required by any applicable laws and ordinances. Post such permits and inspection Certificates in a prominent place adjacent to the work. Deliver all certificates of final inspection or approval to the Architect/Engineer. Do not cover any concealed work until final inspection has been made and approval certificates obtained.

1.8 DELIVERY, STORAGE, HANDLING, AND INSTALLATION

A. Deliver ductwork, pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent ductwork and pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

C. During installation, provide temporary caps of sufficient material to prevent entrance of dirt, debris, and moisture.

1.9 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Under provisions of commissioning documentation; testing of mechanical equipment, as well as training of owner's operation and maintenance personnel, shall be required in cooperation with the commissioning agent.

D. Refer to the Owner/Utility tie-in schedule.

E. Each contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work.

F. Each contractor shall coordinate its operations with operations, included in different sections, which depend on each other for proper installation, connection, and operation.
   1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
   2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
   3. Make adequate provisions to accommodate items scheduled for later installation.
   4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.

1.10 WARRANTIES

A. In the event that any part of the work or equipment fails (abuse and causes beyond control of the contractor excepted), within this period of guarantee, it shall be replaced by the contractor at no cost to the owner.

B. All mechanical system components and controls shall be provided with a minimum 1-year warranty. Specific mechanical components may have longer warranty periods. Warranty shall be unconditional and include material, labor and response with 24 hours of notification. All warranties to begin at substantial completion and extend for period indicated in the contract documents.

1.11 SYSTEM STARTUP

A. Activation of the heating, ventilating and air conditioning equipment for testing and balancing will be allowed only after the construction is substantially complete, or by permission of the owner's construction representative.

B. Air handling systems used prior to final acceptance shall have specified filters installed during temporary use. Replace the temporary filters if the filters become loaded to capacity during system activation. Install replacement filters upon completion of the work and prior to final acceptance. Record the dates when the filters are changed for system start-up and when spare filters are provided with the commissioning agent documents.

1.12 MAINTENANCE

A. Contractor shall be responsible for maintenance of equipment and systems installed until final acceptance by Owner.

B. Lubricate rotating equipment in accordance with manufacturer's recommendations before activation. Re-lubricate as required during activation and prior to final acceptance.

C. Provide readily accessible and secured copper extensions to bearing lubrication fittings on equipment bearings.

1.13 SITE INSPECTION

A. Contractor shall visit the site prior to submitting Proposal and examine and verify existing conditions. Additional charges will not be allowed due to failure to complete site visit or to include necessary materials and labor to complete the work. Proposal being submitted implies site visit has occurred and contractor understands the conditions which the work will be conducted.

1.14 CONSTRUCTION DOCUMENT INTERPRETATION

A. Any conflict within the documents shall be included with the highest cost.

1.15 TESTING, ADJUSTING AND BALANCING MOTOR PULLEY REQUIREMENTS

A. For all constant speed belt driven fans through 5 hp, Contractor shall provide and install two sets of adjustable motor pulleys. First set shall be installed for initial start-up and shall be based on scheduled data. Factory provided motor pulley may be used if properly sized. The second set shall be installed after the balance is complete and shall be based on actual field conditions as determined by the TAB contractor. Select motor pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.

B. For all belt driven variable frequency drive operated fans, contractor shall provide and install one set of fixed motor pulleys sized to allow full utilization of fan motor horsepower provided, with VFD at 100 percent of fan motor RPM

C. Furnish motor pulleys of machined cast iron or carbon steel, bushing type of fixed bore, secured to the shaft by key and keyway.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21, 22, and 23 piping sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 21, 22, and 23 piping sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inchmaximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8-inchthick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:
1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
1. Manufacturers:
a. Cascade Waterworks Mfg. Co.
b. Dresser Industries.
c. Ford Meter Box Company.
d. JCM Industries.
e. Smith-Blair.
f. Viking Johnson.
2. Underground Piping NPS 1-1/2and smaller: Manufactured fitting or coupling.
3. Underground Piping NPS 2and larger: AWWA C219, metal sleeve-type coupling.
4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
1. Manufacturers:
a. Eslon Thermoplastics.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
1. Manufacturers:
a. Thompson Plastics.

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
1. Manufacturers:
a. Nibco.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psigminimum working pressure at 180 deg F.
1. Manufacturers:
a. Capitol Manufacturing Co.

b. Central Plastics Company.
c. Eclipse.
d. Epco Sales.
e. Hart Industries.
f. Watts.
g. Zurn Industries.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psigworking pressure as required to suit system pressures.
1. Manufacturers:
a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Epco Sales.
d. Watts.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
1. Manufacturers:
a. Advance Products & Systems.
b. Calpico.
c. Central Plastics Company.
d. Pipeline Seal and Insulator.
2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psigminimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psigminimum working pressure at 225 deg F.
1. Manufacturers:
a. Calpico.
b. Lochinvar.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psigminimum working pressure at 225 deg F.
1. Manufacturers:
a. Perfection Corp.
b. Precision Plumbing Products.
c. Sioux Chief Manufacturing Co.
d. Victaulic Company.

2.6 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Advance Products & Systems.
2. Flexicraft Pipeseal.
3. Calpico.

4. Metraflex.
5. Pipeline Seal and Insulator.

B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

C. Pressure Plates: Glass reinforced plastic. Include two for each sealing element.

D. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.

B. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.

C. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, with plain ends and integral welded waterstop collar.

D. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.8 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems.
2. Airex Manufacturing.
3. CALPICO.
4. GPT; an EnPro Industries company.
5. Metraflex Company.
6. Proco Products.

B. Description:
1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20-psig.
1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
2. Pressure Plates: Stainless steel
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.9 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, Inc.
   2. CALPICO, Inc.
   3. GPT; an EnPro Industries company.
   4. Metraflex Company (The).
   5. Presealed Systems.
   6. Proco Products, Inc.

B. Description:
   1. Manufactured plastic, sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.
   2. Plastic or rubber waterstop collar with center opening to match piping OD.

2.10 ESCUTCHEONS

A. Description: Manufactured chrome plated wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

C. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

D. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

E. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

F. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.11 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.12 GROUT

A. Description: Nonshrink, recommended for interior and exterior sealing openings in nonfire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.13 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, use NT.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. GE Construction Sealants; Momentive Performance Materials Inc.
      b. Pecora Corporation.
      c. Permathane®/Acryl-R®; ITW Polymers Sealants North America.
      d. Polymeric Systems, Inc.
      e. Sherwin-Williams Company (The).
      f. The Dow Chemical Company.
   2. Sealant shall have a VOC content of 250 g/L or less.

B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. May National Associates, Inc.; a subsidiary of Sika Corporation.
   2. Sealant shall have a VOC content of 250 g/L or less.

C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Smooth-On.
   2. Sealant shall have a VOC content of 250 g/L or less.

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Sections "Selective Demolition" and “Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
4. Equipment to Be Removed: Disconnect and cap services and remove equipment.
5. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
6. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 WORK IN EXISTING BUILDINGS

A. Access to the existing building will be provided by the owner as required and a project schedule will identify access requirements to occupied buildings. Work shall be completed by the Contractor without interruption once Work has begun to facilitate returning the areas of work back to the Owner as soon as possible.

B. Provide adequate protection of all existing and newly installed Work. Contractor shall promptly repair any damage to new or existing Work at Contractor’s expense.

C. Contractor shall consult with the Owner on methods of performing Work so the Owner’s operation is not disrupted more than absolutely necessary. The Owner shall designate when interruption of existing services may occur. Contractor shall leave all services in operation until such time.

D. All items and equipment removed as part of the demolition process shall remain property of the owner unless possession rights are waived. Contractor shall meet with Owner prior to start of demolition to determine which items are to be salvaged. Contractor shall remove remaining items from the site.

3.3 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21, 22, 23 sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated.

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 indicated to be exposed in finished areas as high as possible unless noted otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Install piping to permit valve servicing. Valves shall be located not more than 24 inches above the suspended ceiling grid.

H. Install piping at indicated slopes.

I. Install piping free of sags and bends. Piping shall be installed level and plumb where piping slopes are not required.

J. Install fittings for changes in direction and branch connections.

K. Install piping to allow application of insulation.

L. Select system components with pressure rating equal to or greater than system operating pressure.

M. Install escutcheons for penetrations of walls, ceilings, and floors:
   1. 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. Piping in High Humidity Areas: One-piece, cast-brass type with polished chrome-plated finish.
      d. Insulated Piping: One-piece, stamped-steel type with spring clips.
      e. Bare Piping in Finished Spaces: One-piece, stamped-steel type.
      f. Bare Piping in Unfinished Service Spaces and Equipment Rooms: Split-plate, stamped-steel type with concealed hinge and set screw.
      g. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
   2. Existing Piping: Use the following:
      a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
      b. Piping in High Humidity Areas: Split-casting, cast-brass type with chrome-plated finish.
      c. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
      d. Bare Piping: Split-plate, stamped-steel type with set screw or spring clips.

N. Sleeves are not required for core-drilled holes.

O. Permanent sleeves are not required for holes formed by removable PE sleeves.

P. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

Q. Install sleeves for pipes passing through footings and foundation walls, masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces of walls.
      a. Exception: Extend sleeves installed in floors 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inchannular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a. Schedule 40 Black Steel Sleeves: For pipes smaller than NPS 12 penetrating interior walls.
      b. 0.375-Inch Wall Black Steel Sleeves: For pipes NPS 12 and larger penetrating interior walls.
      c. Schedule 40 Galvanized Steel Sleeves: For pipes smaller than NPS 12 penetrating floors, and roof slabs.
      d. 0.375-Inch Wall Galvanized Steel Sleeves: For pipes NPS 12 and larger penetrating floors and roof slabs.
      e. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
   4. Seal sleeves in concrete floors roof slabs and masonry walls with grout.
   5. Seal sleeves in plaster/gypsum board partitions with plaster or dry wall compound and caulk with non-hardening silicone sealant to provide airtight installation.
   6. 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 07 Section "Joint Sealants" for materials and installation.
   7. Sleeves through floors and walls shall be sized so that the required pipe insulation is continuous through the sleeve.

R. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inchannular 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.

S. 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-inchannular 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.

T. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

U. Verify final equipment locations for roughing-in.

V. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

W. Contractor shall maintain adequate clearances (per the latest edition of the national electric code) above and around any new electrical panels, equipment, and transformers when routing overhead piping.

3.4 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21, 22, and 23 sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

J. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   1. PVC Non-pressure Piping: Join according to ASTM D 2855.

3.5 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2and smaller, adjacent to each control valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2and larger, adjacent to each control valve and at final connection to each piece of equipment.
   3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated or coordination with other services dictates different mounting heights.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.7 ACCESS DOOR INSTALLATION

A. Access doors shall be provided in all pipe chases, soffits, walls, ceilings, and ductwork to give access to valves, dampers, both sides of booster coils in ductwork or VAV terminals, control devices, etc.

B. All access doors shall be within 24 inches of any fire damper.

C. Coordinate the exact location with other trades.

D. Verify the exact quantity, size and location of the required access panels after the installation of systems and equipment requiring access, and prior to the closure of affected ceilings and building assemblies.

3.8 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in Division 09 Section 099123 "Interior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section 055000 "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
   1. Provide all supplementary steel to provide proper drainage for gravity flow systems.

C. Field Welding: Comply with AWS D1.1.

3.10 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.11 GROUTING

A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Cure placed grout.

END OF SECTION 230500

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR MECHANICAL EQUIPMENT

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. Division 23, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 013100 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

B. Section does not include motors for fire pumps, elevators, centrifugal chillers, sealed refrigeration equipment, submersible sump pumps, and vertical hollow or solid shaft motors used with vertical turbine pumps.

1.3 DEFINITIONS

A. ABMA: American Bearing Manufacturers Association.

B. IEEE: Institute of Electrical and Electronics Engineers.

C. NEMA: National Electrical Manufacturers Association.

D. MG 1: (NEMA) Motors and Generators Standard.

E. VFD: Variable frequency drive.

1.4 SUBMITTALS

A. Submit the following product data for approval:
   1. Manufacturer information.
   2. Dimensions and elevations.
   3. Complete NEMA nameplate electrical data including design type, insulation, service factor, and efficiency.

4. Materials of construction.
   a. Bearing type, L10 bearing life, and seal construction (open, single, or double shielded).
5. Certification that VFD driven motors comply with all parts of NEMA MG-1 Part 31.

1.5 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
   1. Baldor Electric Company
   2. Dayton.
   3. General Electric.
   4. Leeson Electric.
   5. Marathon Electric.
   6. Reliance Electric.
   7. Toshiba Corporation.
   8. U.S. Electrical Motors.

2.2 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in Fire Protection, Plumbing or HVAC equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Comply with ABMA 9 for bearing life calculations. For belted applications, calculations shall be based on maximum external side load limits per NEMA MG 1 Table 14-1A. L10 life calculations for vertical motors and horizontal motors mounted in the vertical position shall consider the application's thrust loading.

2.3 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 104 deg F and at altitude of 3300 feet above sea level. Maximum hot spot temperature shall not exceed the insulation temperature limit, when operated in an ambient temperature of 104 deg F, except as otherwise indicated.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Noise: Motors shall not exceed dBA levels listed in NEMA MG 1 section 12.54 at all speeds.

2.4 POLYPHASE MOTORS (1/2 HP and larger)

A. Description: NEMA MG 1, Design B, squirrel cage, medium induction motor with open drip proof enclosure unless noted otherwise in equipment specifications of schedules. When totally enclosed fan cooled motors are specified or scheduled, provide external shaft slinger on drive end.

B. Efficiency: Nominal (nameplate) full load efficiency and corresponding minimum efficiency equal to or greater than that stated in NEMA MG 1 Table 12-12 – Premium Efficient Motors Nominal Full Load Efficiencies.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:
   1. Manufacturer's standard starting characteristic.

J. Enclosure Material and Bearings:
   1. Motors less than 3 HP: Steel or cast iron motor frames, cast aluminum, cast iron, or steel end plates, steel or cast iron terminal box, copper windings.
      a. Bearings shall be regreasable with relief plugs, pre-lubricated ball bearings suitable for radial and thrust loading of the application, with grease fittings, selected for a minimum L10 bearing life of 26,280 hours, for belted and direct drive.
   2. Motors 3 HP and above: Cast iron motor frames and mounting feet, cast iron end plates (bells), steel or cast iron terminal box, copper windings.
      a. Bearings shall be regreasable with relief plugs, pre-lubricated ball bearings suitable for radial and thrust loading of the application, with grease fittings. Rated for a minimum L10 bearing life of 40,000 hours for belted or 130,000 hours for direct drive.

2.5 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers:
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Inverter-Duty Motors: Class B temperature rise; Class H insulation.
   3. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
   4. For VFD driven motors, provide a maintenance free, circumferential conductive micro-fiber ground ring installed on the motor to discharge stray shaft currents to ground. Grounding ring shall be AEGIS SGR (shaft grounding ring). Motors protected by AEGIS SGR shall be warranted for the term of the manufacturer's motor warranty from induced current bearing damage.
   5. Motors protected by AEGIS SGR shall be warranted for the term of the manufacturer's motor warranty from induced current bearing damage.

2.6 SINGLE-PHASE MOTORS (less than 1/2 HP)

A. Motors larger than 1/20 HP shall be one permanent-split-capacitor type, to suit starting torque and requirements of specific motor application:

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

F. Furnish with sliding base/slotted mounting holes adequate for proper belt tensioning and alignment of motor or motor/load.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and align motors in accordance with the equipment manufacturer's recommendations.

B. For VFD driven motors using a shaft grounding ring: Install grounding ring in accordance with the manufacturer's recommendations, including application of a colloidal silver shaft coating on the motor shaft.

3.2 COMMISSIONING

A. Perform commissioning activities as outlined in Division 1 Section, Commissioning Requirements, and other requirements of the Contract Documents.

3.3 ADJUSTING, CLEANING, PROTECTION

A. Assure motor nameplate is legible and properly affixed.

B. Verify bearings are factory lubricated before starting motors. Lubricate per manufacturer's instructions. Do not over lubricate bearings.

C. Check motors for unusual heating, noise, or excessive vibration during operation. Correct any such deficiencies.
   1. Any motors with vibration exceeding specified limits, as noted in the Testing, Adjusting, and Balancing Section, or manufacturer's recommendations, whichever is more stringent, shall be corrected, at no cost to the Owner, until reduced below those limits.

D. Clean the motor prior to start-up and immediately prior to final turn-over to the Owner.

END OF SECTION 230513

SECTION 230523 - GENERAL-DUTY VALVES FOR 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.

B. Division 23, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 013100 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.

1.2 SUMMARY

A. Section Includes:
1. Bronze angle valves.
2. Bronze ball valves.
3. Iron gate valves.
4. Iron globe valves.
5. Drain Valves.

B. Related Sections:
1. Division 23 Section 230553 "Mechanical Identification" for valve tags and schedules.

1.3 DEFINITIONS

A. ASME: American Society of Mechanical Engineers.

B. ASTM: American Society for Testing and Materials.

C. AWWA: American Water Works Association.

D. CWP: Cold working pressure.

E. EPDM: Ethylene propylene copolymer rubber.

F. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Inc.

G. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

H. NRS: Nonrising stem.

I. OS&Y: Outside screw and yoke.

J. PTFE: Polytetrafluoroethylene plastic.

K. RS: Rising stem.

L. TFE: Tetrafluorethylene plastic.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

1.6 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 handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. 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.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Actuator Types:
1. Handwheel: For valves other than quarter-turn types.
2. Handlever: For quarter-turn valves NPS 6 and smaller

G. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

H. Valve-End Connections:
1. Solder Joint: With sockets according to ASME B16.18.
a. Caution: Disassemble valves when soldering, as recommended by the manufacturer, to prevent damage to internal parts.
2. Threaded: With threads according to ASME B1.20.1.

I. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE ANGLE VALVES

A. Class 150, Bronze Angle Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Valve Group; Crane Valves.
b. Crane Valve Group; Jenkins Valves.
c. Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. Nibco.
g. Powell Valves.
2. Description:
a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 300 psig.
c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: PTFE or TFE.
g. Packing: Asbestos free.

h. Handwheel: Malleable iron

2.3 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Hammond Valve.
d. Lance Valves.
e. Milwaukee Valve Company.
f. Nibco.
g. Watts.
2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.4 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Flo Fab Inc.
e. Hammond Valve.
f. Kitz Corporation.
g. Legend Valve.
h. Milwaukee Valve Company.
i. NIBCO INC.
j. Powell Valves.
k. Red-White Valve Corporation.
l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
m. Zy-Tech Global Industries, Inc.
2. Description:
a. Standard: MSS SP-70, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.

e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

B. Class 125, OS&Y, Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Flo Fab Inc.
e. Hammond Valve.
f. Kitz Corporation.
g. Legend Valve.
h. Milwaukee Valve Company.
i. NIBCO INC.
j. Powell Valves.
k. Red-White Valve Corporation.
l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
m. Zy-Tech Global Industries, Inc.
2. Description:
a. Standard: MSS SP-70, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

2.5 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Powell Valves.
i. Red-White Valve Corporation.
j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
k. Zy-Tech Global Industries, Inc.
2. Description:
a. Standard: MSS SP-85, Type I.
b. CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.

d. Ends: Flanged.
e. Trim: Bronze.
f. Packing and Gasket: Asbestos free.

2.6 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
1. Bronze ball valve as specified in this Section.
2. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

PART 3 - EXECUTION

3.1 EXAMINATION

A. 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.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. 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.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball valves.
   2. Throttling Service: Globe, angle, or ball valves.

B. Select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

3.5 LOW-PRESSURE STEAM VALVE SCHEDULE (15 PSIG OR LESS)

A. Pipe NPS 2 and Smaller:
   1. Bronze Angle Valves: Class 125, bronze disc.
   2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
   2. Iron Gate Valves: Class 125,NRS or OS&Y.
   3. Iron Globe Valves, NPS 2-1/2 to NPS 12: Class 125.

3.6 STEAM-CONDENSATE VALVE SCHEDULE

A. Pipe NPS 2and Smaller:
   1. Bronze Angle Valves: Class 125, bronze disc.
   2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.

END OF SECTION 230523

SECTION 230529 - HANGERS AND SUPPORTS

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. Division 23, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 013100 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.

1.2 SUMMARY

A. This Section includes the following hangers and supports for fire protection system, plumbing system, and HVAC system piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Non-metallic pipe hangers and supports.
   4. Metal framing systems.
   5. Non-metallic strut systems
   6. Fastener systems.
   7. Pipe stands.
   8. Equipment supports.

1.3 DEFINITIONS

A. ASCE: American Society of Civil Engineers.

B. ASME: American Society of Mechanical Engineers.

C. ASTM: American Society for Testing and Materials.

D. AWS: American Welding Society.

E. IAPMO: International Association of Plumbing and Mechanical Officials.

F. MFMA: Metal Framing Manufacturers Association.

G. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Inc.

H. SSPC: Steel Structures Painting Council now the Society for Protective Coatings.

I. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Non-metallic pipe hangers and supports.
   3. Thermal-hanger shield inserts.

B. Shop Drawings: Show fabrication and installation details and include calculations stamped by a structural engineer licensed to perform work in the State of Michigan for the following:
   1. Trapeze pipe hangers. Include Product Data for components.
   2. Metal framing systems. Include Product Data for components.
   3. Non-metallic strut systems. Include Product Data for components.
   4. Pipe stands. Include Product Data for components.
   5. Equipment supports.

C. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   2. AWS D1.3, "Structural Welding Code--Sheet Steel."
   3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AAA Technology & Specialties Co., Inc.
   2. Anvil International.
   3. Bergen-Power Pipe Supports.
   4. B-Line Systems, Inc.; a division of Cooper Industries.

5. Carpenter & Paterson, Inc.
6. Empire Industries, Inc.
7. ERICO/Michigan Hanger Co.
8. Globe Pipe Hanger Products, Inc.
9. Grinnell Corp.
10. GS Metals Corp.
11. National Pipe Hanger Corporation.
12. PHD Manufacturing, Inc.
13. PHS Industries, Inc.
14. Piping Technology & Products, Inc.
15. Tolco Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Non-metallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel or stainless steel channels and other components with appropriate finish based on location of use.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Anvil International.
2. B-Line Systems, Inc.; a division of Cooper Industries.
3. ERICO/Michigan Hanger Co.; ERISTRUT Div.
4. GS Metals Corp.
5. Power-Strut Div.; Tyco International, Ltd.
6. Thomas & Betts Corporation.
7. Tolco Inc.
8. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal or galvanized surfaces are indicated.

D. Non-metallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig-minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carpenter & Paterson, Inc.
   2. ERICO/Michigan Hanger Co.
   3. PHS Industries, Inc.
   4. Pipe Shields, Inc., a subsidiary of Piping Technology & Products, Inc.
   5. Rilco Manufacturing Company, Inc.
   6. Value Engineered Products, Inc.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. B-Line Systems, Inc.; a division of Cooper Industries.
      b. Empire Industries, Inc.
      c. Hilti, Inc.
      d. ITW Ramset/Red Head.
      e. MKT Fastening, LLC.
      f. Powers Fasteners.

2.7 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping, ductwork and equipment.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ERICO/Michigan Hanger Co.
      b. MIRO Industries.
      c. Portable Pipe Hangers.

C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. MIRO Industries.
      b. Rector Seal

2.8 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel or stainless steel shapes with appropriate finish based on location of use.

2.9 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Stainless Steel: ASTM A 304, stainless steel plates, shapes, and bars.

C. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and non-metallic grout; suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use padded hangers for piping that is subject to scratching.

E. Holes shall not be drilled or punched in beams and supporting members. Do not support piping from roof deck, other piping, ducts, or equipment.

F. Hangers and supports shall also be provided at every change in direction and within 12 inches of any pipe fitting and valves.

G. Hanger components shall not be used for purposes other than for which they were designed.

H. Vertical runs of piping not subject to appreciable expansion shall be supported by approved wrought steel clamps or collars, securely clamped to the risers. Where required, spring supports and guides shall be provided.

I. Where negligible movement of pipe occurs at hanger locations, rod hangers may be used for suspended lines. For piping supported from below, braces, brackets or structural cross members may be used.

J. If the vertical angle of the hanger is greater than 4 degrees, a traveling device shall be provided for horizontal movement. For piping supported from below, rollers or roll carriages shall be used.

K. Where significant vertical movement of the pipe occurs at the hanger location, a resilient support shall be used. Spring cushion hangers may be used where vertical movement does not exceed 1/4 inches.

L. Pipe attachments for insulated pipe shall be outside the insulation. Insulation protection shields or high density insulation inserts shall be provided to protect the insulation.

M. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
   2. 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.
   3. 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.
   4. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
   5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
   6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
   7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
   8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.

9. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
10. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
11. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
12. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
13. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
14. 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.
15. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
16. 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.
17. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

N. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

O. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches 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.

P. Building Attachments: Use of “C” clamps and beam clamps of “C” pattern and any modification thereof for pipe sizes 2-1/2 inches and larger is prohibited unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
5. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
6. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
7. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
8. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
9. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
10. 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.
11. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
12. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
13. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

Q. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
2. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

R. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

S. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

T. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

U. Use pipe positioning systems (Sioux Chief or approved equal) in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

A. Provide necessary piping and equipment supporting elements including building structure attachments, supplementary steel, hanger rods, stanchions and fixtures, vertical pipe attachments, horizontal pipe attachments, anchors, guides, spring supports in accordance with the referenced codes, standards, and requirements specified. Support piping and equipment from building structure, not from roof deck, floor slab, or other pipes, ducts, or equipment.

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

C. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified 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 D1.1.

D. Non-metallic Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

E. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

G. Fastener System Installation:
   1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

H. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane. Bases shall have sufficient footprint direct contact area to limit loading on roof membrane to be within roofing manufacturer’s limitations so as to not void the roofing warranty.
   2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.

I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

L. Install lateral bracing with pipe hangers and supports to prevent swaying.

M. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

O. 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.
      c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   5. Insert Material: Length at least as long as protective shield.
   6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.

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 Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touch Up: 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. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 230529

SECTION 230553 – MECHANICAL IDENTIFICATION

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. Division 23, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 013100 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.

1.2 SUMMARY

A. Section Includes:
1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Valve tags.
6. 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. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
   1. Brady Co.
   2. Brimar.
   3. Craftmark.
   4. Emed.
   5. Marking Services, Inc.
   6. Seton Name Plate Corp.

2.2 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, black background with white letters, plastic labels for mechanical engraving, 1/16-inch-thick, and having predrilled holes for attachment hardware.
   2. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   4. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   5. Fasteners: Stainless-steel self-tapping screws
   6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.3 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black

C. Background Color: Yellow

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel self-tapping screws

H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.4 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

2.5 DUCT LABELS

A. Material: Color coded self-adhesive duct markers.

B. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

C. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

D. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

2.6 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
   1. Tag Material: Brass, 0.032-inchminimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass wire-link or beaded chain; or S-hook

B. Valve Schedules: For each piping system on 8-1/2-by-11-inch 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 modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

2.7 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
1. Size: 3 by 5-1/4 inches minimum
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 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. Spaced at maximum intervals of 25 feet along each run.

B. Pipe Label Color Schedule:
1. Natural Gas Piping:
a. Background Color: Yellow.
b. Letter Color: Black.

2. Refrigerant Piping:
   a. Background Color: Blue].
   b. Letter Color: White
3. Low-Pressure Steam Piping:
   a. Background Color: Yellow.
   b. Letter Color: Black
4. Steam Condensate Piping:
   a. Background Color: Yellow.
   b. Letter Color: Black

3.4 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
   1. Blue: For supply ducts.
   2. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

B. Locate labels 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.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, valves within factory-fabricated equipment units; shutoff valves; faucets; 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 according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
   1. Valve-Tag Size, Color and Shape: 1-1/2 inches round natural color.

3.6 WARNING-TAG INSTALLATION

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

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

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. Division 23, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 013100 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.

1.2 SUMMARY

A. This Section includes TAB to produce design objectives for the following:
   1. Air Systems:
      a. Constant-volume air systems.
   2. Steam systems.
   3. Kitchen hood airflow balancing.
   4. Verifying that automatic control devices are functioning properly.
   5. Reporting results of activities and procedures specified in this Section.

1.3 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 submains, 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. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

J. 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.

K. TAB: Testing, adjusting, and balancing.

L. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

M. Test: A procedure to determine quantitative performance of systems or equipment.

N. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

A. Qualification Data: Within **30** days from Contractor's Notice to Proceed, submit digital 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 digital copies of the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within **60** days from Contractor's Notice to Proceed, submit digital 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 copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

E. Sample Report Forms: Submit two sets of sample TAB report forms.

F. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by AABC, NEBB, or TABB.

B. Acceptable TAB Firms: Subject to compliance with requirements, select from one of the following TAB firms:
   1. Absolut Balance Co.
   2. Air Flow Testing, Inc.

3. Barmatic Inspecting Co.
4. Ener-Tech.
5. EnviroAire – Total Balance, Inc.
6. International Test & Balance, Inc

C. 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 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.

D. 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.

E. 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.", or SMACNA's TABB "HVAC Systems - Testing, Adjusting, and Balancing."

F. 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."

G. Instrumentation Calibration: Calibrate instruments at least every six 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.

H. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

I. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. 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.

1.7 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 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.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
   1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
   2. 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 systems and equipment.

C. Examine Project Record Documents described in Division 01 Section "Project Record Documents."

D. Examine design data, including system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about 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 system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine 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.

K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

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 equipment for installation and for properly operating safety interlocks and controls.

O. 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 multizone units, mixing boxes, and variable-air-volume terminals.
   4. Automatic modulating and shutoff valves, including two-way valves, are properly connected.

5. Thermostats 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.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:
1. Permanent electrical power wiring is complete.
2. Automatic temperature-control systems are operational Equipment and duct access doors are securely closed.
3. Balance dampers are open.
4. Isolating and balancing valves are open and control valves are operational.
5. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
6. 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 ASHRAE 111 and this Section.
1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

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. Crosscheck 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 an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
      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, heat recovery equipment, and air washers, 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 Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
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, submain 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 submain 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. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain 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 pump flow rate. Correct variations that exceed plus or minus 5 percent.

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. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
   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.

3.7 PROCEDURES FOR STEAM SYSTEMS

A. Measure and record upstream and downstream pressure of each piece of equipment.

B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.

C. Check the setting and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record the final setting.

D. Check the settings and operation of each safety valve. Record settings.

E. Verify the operation of each steam trap.

3.8 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 and measured voltage, each phase.
   6. Nameplate and measured amperage, each phase.
   7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.9 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.10 PROCEDURES FOR HEAT-TRANSFER COILS

A. Steam Coils: Measure the following data for each coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Airflow.
   3. Air pressure drop.
   4. Inlet steam pressure.

B. Refrigerant Coils: Measure the following data for each coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Wet-bulb temperature of entering and leaving air.
   3. Airflow.
   4. Air pressure drop.
   5. Refrigerant suction pressure and temperature.

3.11 PROCEDURES FOR COMMERCIAL KITCHEN HOODS

A. Measure, adjust, and record the airflow of each kitchen hood. For kitchen hoods designed with integral makeup air, measure and adjust the exhaust and makeup airflow. Measure airflow by duct Pitot-tube traverse. If a duct Pitot-tube traverse is not possible, provide an explanation in the report of the reason(s) why and also the reason why the method used was chosen.
   1. Install welded test ports in the sides of the exhaust duct for the duct Pitot-tube traverse. Install each test port with a threaded cap that is liquid tight.

B. After balancing is complete, do the following:
   1. Measure and record the static pressure at the hood exhaust-duct connection.
   2. Measure and record the hood face velocity. Make measurements at multiple points across the face of the hood. Perform measurements at a maximum of 12 inches between points and between any point and the perimeter. Calculate the average of the measurements recorded. Verify that the hood average face velocity complies with the Contract Documents and governing codes.
   3. Check the hood for capture and containment of smoke using a smoke emitting device. Observe the smoke pattern. Make adjustments to room airflow patterns to achieve optimum results.

C. Visually inspect the hood exhaust duct throughout its entire length in compliance with authorities having jurisdiction. Begin at the hood connection and end at the point it discharges outdoors. Report findings.
   1. Check duct slopes as required.
   2. Verify that duct access is installed as required.

3. Verify that point of termination is as required.
4. Verify that duct air velocity is within the range required.
5. Verify that duct is within a fire-rated enclosure.

D. Report deficiencies.

3.12 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: 0 to +10%.
2. Air Outlets and Inlets: -5% to +5%.
3. Heating-Water Flow Rate: 0 to +10%.

3.13 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 and each building floor for systems serving multiple floors.

3.14 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. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. 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. Inlet vane settings for variable-air-volume systems.
    e. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following as applicable:
1. Quantities of outside, supply, return, and exhaust airflows.
2. 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. 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. Return-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. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btuh.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Sheave dimensions, center-to-center, and amount of adjustments in inches.
2. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btuh.
i. High-fire fuel input in Btuh.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btuh.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btuh.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
   1. Fan Data:
      a. System identification.
      b. Location.
      c. Make and type.
      d. Model number and size.
      e. Manufacturer's serial number.
      f. Arrangement and class.
      g. Sheave make, size in inches, 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. Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
   1. Report Data:
      a. System and air-handling unit number.
      b. Location and zone.
      c. Traverse air temperature in deg F.
      d. Duct static pressure in inches wg.
      e. Duct size in inches.
      f. Duct area in sq. ft..
      g. Indicated airflow rate in cfm.
      h. Indicated velocity in fpm.
      i. Actual airflow rate in cfm.
      j. Actual average velocity in fpm.
      k. Barometric pressure in psig.

J. Air-Terminal-Device Reports:
   1. Unit Data:
      a. System and air-handling unit identification.
      b. Location and zone.
      c. Test apparatus used.
      d. Area served.
      e. Air-terminal-device make.

f. Air-terminal-device number from system diagram.
g. Air-terminal-device type and model number.
h. Air-terminal-device size.
i. Air-terminal-device effective area in sq. ft.

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. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:

1. Unit Data:
a. Unit identification.
b. Location.
c. Unit make and model number.
d. Compressor make.
e. Compressor model and serial numbers.
f. Refrigerant weight in lb.
g. Low ambient temperature cutoff in deg F.

2. Test Data (Indicated and Actual Values):
a. Inlet-duct static pressure in inches wg.
b. Outlet-duct static pressure in inches wg.
c. Entering-air, dry-bulb temperature in deg F.
d. Leaving-air, dry-bulb temperature in deg F.
e. Condenser entering-water temperature in deg F.
f. Condenser leaving-water temperature in deg F.
g. Condenser-water temperature differential in deg F.
h. Condenser entering-water pressure in feet of head or psig.
i. Condenser leaving-water pressure in feet of head or psig.
j. Condenser-water pressure differential in feet of head or psig.
k. Control settings.
l. Unloader set points.
m. Low-pressure-cutout set point in psig.
n. High-pressure-cutout set point in psig.
o. Suction pressure in psig.
p. Suction temperature in deg F.
q. Condenser refrigerant pressure in psig.
r. Condenser refrigerant temperature in deg F.
s. Oil pressure in psig.
t. Oil temperature in deg F.
u. Voltage at each connection.
v. Amperage for each phase.
w. Kilowatt input.
x. Crankcase heater kilowatt.

y. Number of fans.
z. Condenser fan rpm.
aa. Condenser fan airflow rate in cfm.
bb. Condenser fan motor make, frame size, rpm, and horsepower.
cc. Condenser fan motor voltage at each connection.
dd. Condenser fan motor amperage for each phase.

L. Instrument Calibration Reports:
1. Report Data:
a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.15 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 room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
b. Verify that balancing devices are marked with final balance position.
c. 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.

3.16 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

SECTION 230700 - MECHANICAL INSULATION

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. Division 23, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 013100 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.

1.2 SUMMARY

A. Section Includes:
   1. Insulation Materials:
      a. Flexible elastomeric.
      b. Mineral fiber.
   2. Insulating cements.
   3. Adhesives.
   4. Mastics.
   5. Sealants.
   6. Factory-applied jackets.
   7. Tapes.
   8. Securements.
   9. Corner angles.
   10. Protective shielding guards

B. Related Sections:
   1. Division 23 Section 233113 "Metal Ducts" for duct liners.

1.3 DEFINITIONS

A. ASHRAE/IESNA: American Society of Heating, Refrigeration, Air Conditioning Engineers/Illuminating Engineering Society of North America.

B. ASTM: American Society for Testing and Materials.

C. CFC: Chlorinated Fluorocarbon.

D. HCFC: Hydrogenated Chlorofluorocarbon.

E. LEED: Leadership in Energy and Environmental Design.

F. MIL: Military.

G. NPS: Nominal Pipe Size.

H. VOC: Volatile Organic Compound.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Schedule of insulation types, densities, and thicknesses for each type of item being insulated.

C. Qualification Data: For qualified Installer.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section 230529 "Hangers and Supports."

B. Coordinate clearance requirements with piping Installer for piping insulation application, and duct Installer for duct insulation application.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA, Inc.; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

D. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; SoftTouch Duct Wrap.
      b. Johns Manville; Microlite.
      c. Knauf Insulation; Atmosphere Duct Wrap.
      d. Manson Insulation Inc.; Alley Wrap.
      e. Owens Corning; SOFTR All-Service Duct Wrap.

E. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; CertaPro Commercial Board.
      b. Fibrex Insulations Inc.; FBX.
      c. Johns Manville; 800 Series Spin-Glas.
      d. Knauf Insulation; Earthwool Insulation Board.
      e. Manson Insulation Inc.; AK Board.

f. Owens Corning; Fiberglas 700 Series.

F. Mineral-Fiber, Preformed Pipe Insulation:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; Earthwool 1000° Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSLjacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Ramco Insulation, Inc.; Super-Stik.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
d. K-Flex USA; R-373 Contact Adhesive.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
b. Eagle Bridges - Marathon Industries; 225.

c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. ASJ Adhesive, and FSK Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
d. Mon-Eco Industries, Inc.; 22-25.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Dow Corning Corporation; 739, Dow Silicone.
b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Speedline Corporation; Polyco VP Adhesive.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
      b. Vimasco Corporation; 749.
   2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
   5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
      b. Eagle Bridges - Marathon Industries; 550.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
      d. Mon-Eco Industries, Inc.; 55-50.
      e. Vimasco Corporation; WC-1/WC-5.
   2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: 60 percent by volume and 66 percent by weight.
   5. Color: White.

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
      b. Eagle Bridges - Marathon Industries; 405.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
      d. Mon-Eco Industries, Inc.; 44-05.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: Aluminum.
   6. 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).
   7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. ASJ Flashing Sealants, and PVC Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: White.
   6. 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).
   7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
   1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
      a. Sheet and roll stock ready for shop or field sizing
      b. Finish and thickness are indicated in field-applied jacket schedules.
      c. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and Kraft paper
      d. Factory-Fabricated Fitting Covers:
         1) Same material, finish, and thickness as jacket.
         2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         3) Tee covers.
         4) Flange and union covers.
         5) End caps.
         6) Beveled collars.
         7) Valve covers.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ABI, Ideal Tape Division; 428 AWF ASJ.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
      c. Compac Corporation; 104 and 105.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ABI, Ideal Tape Division; 491 AWF FSK.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      c. Compac Corporation; 110 and 111.
      d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ABI, Ideal Tape Division; 370 White PVC tape.
      b. Compac Corporation; 130.
      c. Venture Tape; 1506 CW NS.
   2. Width: 2 inches.
   3. Thickness: 6 mils.
   4. Adhesion: 64 ounces force/inch in width.
   5. Elongation: 500 percent.
   6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ABI, Ideal Tape Division; 488 AWF.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
      c. Compac Corporation; 120.
      d. Venture Tape; 3520 CW.
   2. Width: 2 inches.

3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.9 SECUREMENTS

A. Insulation Pins and Hangers:
   1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inchdiameter shank, length to suit depth of insulation indicated.
      a. Products: Subject to compliance with requirements, provide one of the following:
         1) AGM Industries, Inc.; CWP-1.
         2) GEMCO; CD.
         3) Midwest Fasteners, Inc.; CD.
         4) Nelson Stud Welding; TPA, TPC, and TPS.
   2. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
      a. Products: Subject to compliance with requirements, provide one of the following:
         1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
         2) GEMCO; Perforated Base.
         3) Midwest Fasteners, Inc.; Spindle.
      b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
      c. Spindle: Copper- or zinc-coated, low carbon steel fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
      d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
   3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
      a. Products: Subject to compliance with requirements, provide one of the following:
         1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
         2) GEMCO; Peel & Press.
         3) Midwest Fasteners, Inc.; Self Stick.
      b. Baseplate: Galvanized carbon-steel sheet, 0.030-inch-thick by 2 inches square.
      c. Adhesive-backed base with a peel-off protective cover.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

2.10 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040-inch-thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

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.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation (Conditioned Spaces): Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
   1. Comply with requirements in Division 07 Section 078413 "Penetration Firestopping" and fire-resistive joint sealers.

D. Insulation Installation at Floor Penetrations:
   1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
   2. Pipe: Install insulation continuously through floor penetrations.
   3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07, 078413 Section "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

C. Provide protective shielding guards on exposed piping serving barrier free sinks and lavatories.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

3.6 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturers recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where metal jackets are indicated, install with 2-inchoverlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each duct system defined in the "Duct Insulation Schedule, General" Article.
   2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
1. Indoor, concealed supply air.
2. Indoor, exposed supply air.
3. Indoor, concealed oven exhaust.
4. Indoor, exposed oven exhaust.

B. Items Not Insulated:
1. Flexible connectors.
2. Factory-insulated access panels and doors.

3.11 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Refer to “Duct Application Schedule” in the drawings.

3.12 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Refer to “Piping Application Schedule” in the drawings.

B. Condensate and Equipment Drain Water below 60 Deg F:
1. All Pipe Sizes: Insulation shall be the following:
a. Flexible Elastomeric: 1 inchthick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Refrigerant Suction and Hot-Gas Piping:
1. All Pipe Sizes: Insulation shall be the following:
a. Flexible Elastomeric: 1 inch thick.

3.14 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Flexible Elastomeric: 2 inches thick.

3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Refrigerant Piping, Exposed:
   1. Aluminum, Corrugated: 0.016 inch

END OF SECTION 230700

SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

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. Division 23, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 013100 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.

D. Verify Division 1 specification is included in project. Delete if project does not include a construction BIM process.

1.2 DEFINITIONS

A. BAS: Building Automation System

B. DDC: Direct Digital Control

C. EMS: Energy Management System consisting of BAS (typically with a PC and support software), DDC controllers, and networking software/hardware/wiring.

D. I/O: Input/output

E. BACnet: A communications protocol for implementing interoperable controllers established by ASHRAE

F. MS/TP: Master-slave/token-passing network for BACnet

G. PC: Personal computer

H. PID: Proportional plus integral plus derivative

1.3 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
   1. Provide Building Automation System (BAS) as shown in the contract documents and described herein.

2. Provide interface to BAS via BACnet as shown in the contract documents and described herein.
    a. The system shall enable an open architecture that utilizes BACnet functionality to assure interoperability between all system components. Native support for BACnet protocol are required to assure that the project is fully supported by the HVAC open protocols to reduce future building maintenance, upgrade, and expansion costs.
3. Provide DDC System as shown in the contract documents and described herein including but not limited to:
    a. Administration and Programming Workstation(s)
    b. Web-Based Operator Workstations
    c. Ethernet-based Network Router and/or Network Server Controller(s)
    d. Standalone Digital Control Units (SDCUs)
4. Sequences modified as a result of start-up, checkout, fine tuning, and/or commissioning shall be resubmitted to the Architect for record.
5. The system shall also provide a graphical, web-based, operator interface that allows for instant access to any system through a standard browser.

1.4 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:
1. Graphic Display: Display graphic with minimum 30 dynamic points with current data within 5 seconds.
2. Graphic Refresh: Update graphic with minimum 30 dynamic points with current data within 2 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 15 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
    a. Space Temperature: Plus or minus 1-degree F.
    b. Ducted Air Temperature: Plus or minus 1-degree F.
    c. Outside Air Temperature: Plus or minus 2-degrees F.
    d. Averaging Air Temperature: Plus or minus 2-degrees F.
    e. Dew Point Temperature: Plus or minus 2.7-degrees F.
    f. Temperature Differential: Plus or minus 0.27-degrees F.
    g. Relative Humidity: Plus or minus 5-percent relative humidity (% RH).
    h. Airflow (Pressurized Spaces): Plus or minus 2-percent of full scale (% FS).
    i. Airflow (Terminal): Plus or minus 5-% FS.
    j. Air Pressure (Space): Plus or minus 0.0005-inches wg.
    k. Air Pressure (Ducts): Plus or minus 0.02-inches wg.
    l. Carbon Dioxide: Plus or minus 50-ppm CO2.

1.5 SEQUENCE OF OPERATION

A. Sequences of Operation are included on the temperature control drawings (plans).

1.6 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
   1. Building Automation System: Include technical data for operator workstation, operating system software, color graphics; editors for graphics, point database, and programming; software licensing, software updates during construction, and other third-party applications.
   2. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for remote operator's terminal, operator display menus, interface equipment to BAS, DDC Controllers, Unitary Controllers, Application Specific Controllers (e.g. Air Terminal Controller), transducers/transmitters, sensors, control dampers, damper actuators, control valves, valve actuators, relays/switches, auxiliary control panels.
   3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

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. Bill of materials of equipment indicating quantity, manufacturer, and model number.
   2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
   3. Wiring Diagrams: Power, signal, and control wiring.
   4. Details of control panel faces, including controls, instruments, and labeling.
   5. Written description of sequence of operation.
   6. Schedule of dampers including size, leakage, and flow characteristics.
      a. Coordinate dampers sizes with sheet metal and/or mechanical contractor before submitting.
   7. Schedule of valves including flow characteristics.
   8. Schedule of Terminal Equipment Controllers; e.g. air terminals, unit ventilators, etc.
   9. DDC System Hardware:
      a. Wiring diagrams for control units with termination numbers.
      b. Schematic diagrams and floor plans for field sensors and control hardware.
      c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
   10. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.

11. Controlled Systems:
    a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
    c. Written description of sequence of operation including schematic diagram.
    d. Points list.

C. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

D. Samples for Initial Selection: For each color required, of each type of thermostat or sensor cover with factory-applied color finishes.

E. Samples for Verification: For each color required, of each type of thermostat or sensor cover.

F. Software and Firmware Operational Documentation: Include the following:
1. Software operating and upgrade manuals
2. Program Software Backup: On a DVD (CD-ROM) complete with data files
3. Device address list
4. Printout of software application and graphic screens
5. Software licenses required by and installed for DDC workstations and control systems

G. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

H. Qualification Data:
1. Manufacturer’s product line being submitted shall be in full production for at least two years.
2. Installer shall be factory trained and authorized in the installation, startup, check-out and commissioning of the manufacturer’s product line being submitted. Installer’s field personnel shall have at least three years’ experience in the installation of DDC-style temperature control systems.

I. Field quality control test reports

J. Installing contractor’s commissioning reports

K. Operation and Maintenance Data: For HVAC instrumentation and control system 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 instructions and list of spare parts for each type of control device and the compressed air station.
2. Interconnection wiring diagrams with identified and numbered system components and devices.

3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
5. Calibration records and list of set points.

1.7 QUALITY ASSURANCE

A. All bidders must be building automation contractors in the business of installing direct digital control building automation systems for a minimum of 5 years.
   1. The Building Management System contractor shall have a full service facility within 120 miles of the project that is staffed with engineers trained and certified by the manufacturer in the configuration, programming and service of the automation system. The contractor's technicians shall be fully capable of providing instructions and routine emergency maintenance service on all system components.
   2. Any installing contractor, not listed as prequalified in the Approved Manufacturer's section, shall submit credentials as detailed in the Pre-bid Submittal section for the engineer's review 2 weeks prior to bid date. Failure to follow the attached formats shall disqualify potential alternate bidders. Credentials must attest that the contractor meets all requirements of the specification and the Engineers judgment regarding approval to bid as an acceptable installer after reviewing the data will be final.
   3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with ASHRAE 135 for DDC system components.

C. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report will be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.

D. The BAS system supplier shall commission and set in operating condition all major equipment and systems, such as the chilled water, hot water and all air handling systems, in the presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives. If the vendor is providing an AFDD/CC system, use of the analytics shall be used to help commission the system.

E. Startup Testing shall be performed for each task on the startup test checklist, which shall be initialed by the technician and dated upon test was completion along with any recorded data such as voltages, offsets or tuning parameters. Any deviations from the submitted installation plan shall also be recorded.

F. Required elements of the startup testing include:
   1. Measurement of voltage sources, primary and secondary

2. Verification of proper controller power wiring.
3. Verification of component inventory when compared to the submittals.
4. Verification of labeling on components and wiring.
5. Verification of connection integrity and quality (loose strands and tight connections).
6. Verification of bus topology, grounding of shields and installation of termination devices.
7. Verification of point checkout.
8. Each I/O device is landed per the submittals and functions per the sequence of control.
9. Analog sensors are properly scaled and a value is reported
10. Binary sensors have the correct normal position and the state is correctly reported.
11. Analog outputs have the correct normal position and move full stroke when so commanded.
12. Binary outputs have the correct normal state and respond appropriately to energize/de-energize commands.
13. Documentation of analog sensor calibration (measured value, reported value and calculated offset).
14. Documentation of Loop tuning (sample rate, gain and integral time constant).

G. A performance verification test shall also be completed for the operator interaction with the system. Test elements shall be written to require the verification of all operator interaction tasks

H. I. A Startup Testing Report and a Performance Verification Testing Report shall be provided upon test completion

1.8 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.9 COORDINATION

A. Coordinate location of thermostats, humidistats, DDC control sensors, and other exposed control sensors with plans and room details before installation.

B. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

C. Coordinate installation of control dampers, smoke dampers, HVAC equipment isolation dampers, and pipe-mounted sensors and instruments with the mechanical and/or plumbing contractor.

D. Coordinate installation of duct, space, outdoor, or building static pressure sensors with the finished surfaces, installing contractor and the Architect prior to installation.

E. Coordinate installation of any exterior wall or roof-mounted sensors, instruments, photocells, or controllers required for the temperature control system with the General Contractor and the Architect prior to installation.

F. Coordinate the color selection process of any sensor or device intended to be mounted on finished surfaces with the Architect prior to installation.

1.10 OWNERSHIP

A. The Owner shall retain licenses to software for this project.

B. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition off this contractor. Such license shall grant use of all programs and application software to the Owner as defined by the manufacturer's license agreement, but shall protect the manufacturer's rights to disclosure of Trade Secrets contained within such software.

C. The licensing agreement shall not preclude the use of the software by individuals under contract to the owner for commissioning, servicing or altering the system in the future. Use of the software by individuals under contract to the owner shall be restricted to use on the owner's computers and only for the purpose of commissioning, servicing, or altering the installed system.

D. All project developed software, files and documentation shall become the property of the Owner. These include but are not limited to:
1. Server and workstation software
2. Application programming tools
3. Configuration tools
4. Network diagnostic tools
5. Addressing tools
6. Application files
7. Configuration files
8. Graphic files
9. Report files
10. Graphic symbol libraries
11. All documentation

1.11 WORK BY OTHERS

A. The BAS system supplier shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work. The BAS system supplier shall coordinate all installation, devices, and programming for a complete and operational system compliant to the functionality depicted and described in the construction documents.

B. The BAS system supplier shall furnish all Flow Meters for installation by the Mechanical Contractor and/or others.

C. The BAS system supplier shall provide field supervision to the designated contractor for the installation of the following:
   1. Automatic control dampers
   2. Blank-off plates for dampers that are smaller than duct size.
   3. Sheet metal baffles plates to eliminate stratification.
   4. The Electrical Contractor shall provide:
      a. All 120VAC power wiring to motors, heat trace, junction boxes for power to BAS panels.
      b. Furnish smoke detectors and wire to the building fire alarm system. EC to hardwire to fan shut down.

D. Prior to delivery to the Project site, ensure that suitable storage space is available to store materials in a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres. Materials shall be protected during delivery and storage and shall not exceed the manufacturer stated storage requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. In addition, protect electronics from all forms of electrical and magnetic energy that could reasonably cause damage.

E. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified within the Contract Documents.

F. Inspect and report any concealed damage or violation of delivery storage, and handling requirements to the Engineer.

1.12 WARRANTY

A. The control system shall be guaranteed for a period of two years after final approval by the Owner. The guarantee shall be provided for a completely installed system, including all components, parts, and assemblies of the control system. The guarantee shall cover parts, materials, and labor to locate and correct any defects in materials or workmanship.

B. The Contractor shall initiate the warranty period by formally transmitting to the Owner commencement notification of the period for the system and devices accepted. The warranty period begins when these devices are formally accepted by the Owner (refer to ACCEPTANCE PROCEDURE below).

C. Contact information shall be provided for quick service engineering assistance concerning hardware and software problems. There shall be provisions made for getting manufacturer certified diagnostic and repair personnel on the scene quickly should the need arise. There shall also be a software expert familiar with the software of this machine who can be easily contacted.

D. This system shall be inspected by the control system Contractor for a four-hour period once each quarter during the warranty period to run diagnostic tests and also provide maintenance instructions to the operating personnel.

E. The control system Contractor shall give the Owner 24 hours prior notification of each maintenance trip during the contract guarantee period. In addition, the Contractor shall furnish the Owner and Engineer a written record of each maintenance trip, number of employees present, time involved and work accomplished.

F. Owner shall be able to make changes to database, when prior database is stored on disk in case of error in change, without affecting or voiding warranty.

1.13 MAINTENANCE

A. The control system Contractor shall provide and maintain on site working spare parts for the control system during the warranty period including DDC Controllers, power supplies, modules, sensors, floor level (subnet) devices, transformers, etc. The owner will be custodian of these spare parts and shall be authorized to utilize them in performing first level maintenance. The control contractor shall refurbish/replace spare parts in exchange for failed items.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design Product: Subject to compliance with requirements, provide products by one of the following pre-qualified manufacturers:
   1. Electric Components
      a. Schneider-Electric / Distech Controls / Trane Field Devices
   2. Electronic Components
      a. Schneider-Electric/ Distech Controls / Trane Field Devices
   3. Direct Digital Control Systems Field Controller Devices:
      a. Schneider Electric / Distech Controls / Trane

2.2 OPEN, INTEROPERABLE SYSTEM ARCHITECTURE

A. General
   1. The Building Automation System (BAS) shall consist of Network Server/Controllers (NSCs) and a family of Standalone Digital Control Units (SDCUs). All field level controllers must have the ability to be programmed by site personnel from a BAS contractor supplied and licensed programming tool or N4 embedded programming tool jar file.
   2. An Enterprise Level BAS shall consist of an Enterprise Server, which enables multiple NSCs (including all graphics, alarms, schedules, trends, programming, and configuration) to be accessible from a single Workstation simultaneously for operations and engineering tasks.
   3. The Enterprise Level BAS shall support built-in reporting functionality without dependency on other software.

4. The Enterprise Level BAS shall support standard accessing of data for third party reporting or analytics software.
5. The Enterprise Level BAS shall be able to host up to 250 servers, or NSCs, beneath it.
6. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP, and/or Modbus TCP protocol.

B. Modbus RTU/ASCII (and J-bus), Modbus TCP, BACnet MS/TP, BACnet IP, and WebServices shall be native to the NSCs. There shall not be a need to provide multiple NSCs to support all the network protocols, nor should there be a need to supply additional software to allow all three protocols to be natively supported.

C. A sub-network of SDCUs using the BACnet IP, BACnet MS/TP protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.

D. The TCP/IP layer connects all of the buildings on a single Wide Area Network (WAN) isolated behind the campus firewall. Fixed IP addresses for connections to the campus WAN shall be used for each device that connects to the WAN.

E. The fieldbus layer shall support all of the following types of SDCUs:
1. BACnet IP SDCU requirements: The system shall consist of one or more BACnet/IP field buses managed by the Network Server Controller.
2. BACnet MS/TP SDCU requirements: (Only where shown on the control architecture drawings)

F. The system shall consist of one or more BACnet MS/TP field buses managed by the Network Server Controller. Minimum speed shall be 38.4 kbps. The field bus layer consists of an RS485, token passing bus that supports Standalone Digital Control Units (SDCUs) for operation of HVAC. These devices shall conform to BACnet standard 135-2004. The NSCs shall be capable of at least two BACnet MS/TP field buses per NSC.

G. The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN). Workstations can manage a single LAN (or building), and/or the entire system with all portions of that LAN maintaining its own, current database.

H. All NSCs, Workstation(s) and Servers shall be capable of residing directly on the owner’s Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NSC’s, Workstation(s), and Server(s) shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner’s Information Systems Department as all devices utilize standard TCP/IP components. All added BAS supplied switches and routers must be approved by owner’s Information Systems Department.

I. System Expansion
   1. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same TCP/IP level and fieldbus level controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
   2. Web-based operation shall be supported directly by the NSCs and require no additional software.
   3. The system shall be capable of using graphical and/or line application programming language for the Network Server Controllers.
   4. The system shall be able to operate normally and without restriction at multiple software version levels with the only requirement that each element of the hierarchy be at least as new a version as the newest version in the level below it. In other words, Enterprise Servers will be able to manage NSCs of different version provided that the Enterprise Server was the same or more recent version than the most recent NSC version.

J. All Network Server Controllers must natively support the BACnet IP, BACnet MS/TP, Modbus TCP, Modbus RTU (RS-485 and RS-232), and Modbus ASCII protocols.

2.3 OPERATOR WORKSTATION REQUIREMENTS:

A. General
   1. The operator workstation portion of the BAS shall consist of one or more full-powered configuration and programming workstations, and one or more web-based operator workstations. For this project provide a minimum of 3 concurrent client licenses at the enterprise level. Client licenses are licenses that can be used for variable designations of the users choosing; i.e. operator, engineering, or web capabilities.
   2. The programming and configuration workstation software shall allow any user with adequate permission to create and/or modify any or all parts of the NSC and/or Enterprise Server database. All field level controllers must have the ability to be programmed by site personnel from a BAS contractor supplied and licensed programming tool or N4 embedded programming tool jar file.
   3. At the NSC level, there shall be no cap on concurrent web-based workstations (webstations) other than what the CPU capacity can support.
   4. All configuration workstations shall be desktop personal computers operating under the Microsoft Windows operating system. The application software shall be capable of communication to all Network Server Controllers and shall feature high-resolution color graphics, alarming, trend charting. It shall be user configurable for all data collection and data presentation functions.
   5. A minimum of 1 physical Workstation shall be allowed on the Ethernet network. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other workstations since the changes are accomplished to the databases within the NSC. Systems with a central database will not be acceptable.

B. N4 Supervisor, Administration/Programming Workstation, and Webstation requirements
   1. The N4 Supervisor shall consist of the following:
      a. Processor
         1) Minimum: Intel Xeon CPU E5-2640 x64 (or better) compatible with dual and quad core processors
      b. Memory
         1) 64GB or higher recommended
      c. Operating systems:
         1) Microsoft Windows 10 64-bit
         2) Microsoft Windows 11 64-bit
         3) Microsoft Windows Server 2016
         4) Microsoft Windows Server 2019
      d. 10/100MBPS Ethernet NIC
      e. Storage
         1) Minimum: 1TB or higher
         2) Solid State Drive recommended
      f. Required additional software:
         1) Microsoft .Net 4.7.2 and later
      g. License agreement for all applicable software
   2. The Workstation shall consist of the following:
      a. Processor
         1) Minimum: Intel Core i5 @ 2.0 GHz or equivalent
         2) Recommended: Intel Core i5 @ 3.0 GHz or better
      b. Memory
         1) Minimum: 8GB or higher
      c. Operating systems:
         1) Microsoft Windows 10 64-bit
         2) Microsoft Windows 11 64-bit
         3) Microsoft Windows Server 2016
         4) Microsoft Windows Server 2019
      d. 10/100MBPS Ethernet NIC
      e. Storage
         1) Minimum: 20GB
         2) Recommended: 1TB
         3) Solid State Drive recommended
      f. Required additional software:
         1) Microsoft .Net 4.7.2 and later
      g. License agreement for all applicable software
   3. Web-Based Operator PC Requirements
      a. Any user on the network can access the system, using the following software:
      b. Minimum:
         1) Google Chrome 61 or higher
         2) Mozilla Firefox 60 or higher
         3) Microsoft Edge (EdgeHTML) 16 or higher
         4) Safari 11.1 or higher
      c. Recommended:
         1) Google Chrome 71 or higher

2) Mozilla Firefox 64 or higher
3) Microsoft Edge (EdgeHTML) 17 or higher
4) Safari 11.4 or higher

C. General Administration and Programming Workstation Software
1. System architecture shall be truly client server in that the Workstation shall operate as the client while the NSCs shall operate as the servers. The client is responsible for the data presentation and validation of inputs while the server is responsible for data gathering and delivery.
2. The workstation functions shall include monitoring and programming of all DDC controllers. All field level controllers must have the ability to be programmed from the N4 workstation software.
3. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.
4. Programming of SDCUs shall be capable of being done either off-line or on-line from any operator workstation. All information will be available in graphic or text displays stored at the NSC. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.

D. User Interface:
1. The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any workstation. Additionally, it shall be possible to create customized workspaces that can be assigned to user groups. This interface shall support the creation of “hot-spots” that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user’s “PC Desktop” – with all the links that a user needs to run other applications. This, along with the Windows user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software, but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.
2. System shall be able to automatically switch between displayed metric vs. imperial units based on the workstation/webstations localization.
3. The BMS workstation/webstations shall be capable of multiple language display, including English, Spanish, German, French, Japanese, Italian, Finnish, Portuguese, Swedish, Russian, and traditional and simplified Chinese. The multiple languages shall not require additional add on software from the standard workstation installer and shall be selectable within said workstation.
4. Webstations shall have the capability to automatically re-direct to an HTTPS connection to ensure more secure communications.
5. Personalized layouts and panels within workstations shall be extended to webstations to ensure consistent user experiences between the two user interfaces.

6. Webstations shall give the user the same capabilities within the graphics pages as are given within the workstation but shall be mobile responsive for use on smaller devices.
7. Servers and clients shall have the ability to be located in different time zones, which are then synchronized via the NTP server.
8. Workstation shall indicate at all times the communication status between it and the server.
9. The BMS web interface shall enable presentation mode whereby any functionality for interactivity shall be disabled.
10. The BMS web interface shall automatically detect light mode and dark mode settings in the operating system and adapt accordingly.
11. The BMS web interface shall allow override of the operating systems light/dark mode settings so that the setting can be enabled independent of the operating system's setting.
12. The BMS web interface shall automatically respond and adapt to different screen sizes and orientations from smart phone to smart televisions of any size.
13. The BMS web interface shall support slideshow functionality.
14. The BMS web interface shall support full screen mode displaying Alarm views / graphics / dashboards / Custom Reports.

E. User Access and Permissions
1. The BMS system shall allow for creation of one account per user.
2. The BMS shall support Groups where User Accounts associated with the group can inherit group permissions.
3. The BMS shall be able to specify each user account / group accessibility to each object in the system.
4. The BMS permission system shall be possible to integrate with Windows Active directory.
5. The BMS shall be able to report on the permission level across account / group for review / archiving / audit.
6. This username/password combination shall be linked to a set of capabilities within the software, set and editable only by user with system administrator privileges. The sets of capabilities shall include: edit or View only, Acknowledge alarms, Enable/disable Program and change values.
7. The system shall allow the above capabilities to be applied independently to each and every class of object in the system.
8. The BMS shall support integration with Windows Active Directory for user log on credentials.
9. The BMS shall support configurable reminder for "Days until password expires".
10. The BMS shall support configurable password policy across:
    a. Minimum number of characters
    b. Minimum number of lowercase characters
    c. Minimum number of numeric characters
    d. Minimum number of special characters
    e. Number of consecutive unique passwords before reuse
    f. No more than three repeating identical characters
11. The BMS user account management shall support password policy with the following components:
    a. Mandatory change of password at first logon with default credentials

b. Disabling of all imported user accounts by default
c. Custom password complexity rules and its enforcement
d. Custom password reuse and its enforcement
e. Configurable black listing of passwords to limit the use of common known passwords (e.g. password)
f. Password aging rules

12. The BMS shall be capable of enabling an anonymous access (guest account) to previously engineered views such as dashboards, graphics, etc. with configurable permissions and without username or password.
13. It shall be possible to configure the BMS system so that the guest account is used by default to simplify presentation of Kiosk Mode across multiple screens
14. The BMS shall provide time configurability to logout the user and to revert to a preconfigured presentation view, such as offered by the Guest account functionality.
15. The BMS shall provide configurability in managing access and permission levels based on location, IP addresses and address ranges, Schedule and Time of day and combination thereof.

F. System Security
1. The BMS system supplier shall be subjected to regular and verifiable best practice cyber security testing by the system supplier. Results of this testing shall be made available upon request prior to deployment of the system.
2. The BMS system supplier shall provide cyber security service incident escalation through help desk on a 7/24/365 basis.
3. The BMS shall support configuration for inactivity auto log-off of logged clients
4. The BMS system shall support Self-Signed Certificates, Default Certificates and/or Certification Authority (CA) certificates.
5. The BMS client communications (web access or rich client access) shall support TLS 1.2 encryption or higher
6. The BMS shall allow configuration in disabling all devices and software that support HTTP and require access via HTTPS.
7. The BMS must be able to Alarm or generate notification on failed access attempts
8. The BMS Servers shall support SNMP V3 monitoring of network performance and stack statistics for the purpose of managing denial of service attacks
9. The Integrated Control Platform shall support the feature to alarm on a predetermined period of time until the default password for each device is changed from the default factory setting.
10. The Integrated Control Platform shall support encrypted password authentication for all web services whether serving or consuming.
11. The BMS shall have the capability to use blacklisted and whitelisted IPs/MAC addresses to gate access
12. The BMS shall have the capability to differentiate, limit or enable, user access depending on Client’s IP address/range (where) and time of day (when) the user is accessing the system.

G. Configuration Interface:
   1. The workstation software shall use a familiar Windows Explorer style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a “network map” of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions.
   2. The configuration interface shall also include support for user defined object types. These object types shall be used as building blocks for the creation of the BAS database. They shall be created form the base object types within the system input, output, string variables, setpoints, etc., alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of user defined object types shall be able to be set up as a predefined aggregate of subsystems and systems. The configuration interface shall support copying/pasting and exporting/importing portions of the database for additional efficiency. The system shall also maintain a link to all “child” objects created. If a user wishes to make a change to a parent object, the software shall ask the user if he/she wants to update all of the child objects with the change.

H. Color Graphic Displays
   1. The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition, operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.
   2. Requirements of the color graphic subsystem include:
      a. At a minimum, the user shall have the ability to import .gif, .png, .bmp, .jpeg, .tif, and CAD generated picture files as background displays, and layering shall be possible.
      b. The system shall support HTML5 enabled graphics.
      c. It shall be possible for the user to use JavaScript to customize the behavior of each graphic.
      d. The editor shall use Scalable Vector Graphics (SVG) technology.
      e. A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, ad graphs which can be “dropped” on a graphic through the use of a software configuration “wizard”. These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels.
      f. Support for high DPI icons shall be included and automatically chosen if viewing on a high definition display such as Retina or 4K displays.
      g. Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.
      h. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.

i. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.
j. It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries.
k. Graphics should rescale based on whatever monitor or viewing device is being used.
l. Be able to create graphics on varying layers that can be moved and repeated.
m. Be able to create graphics within varying window panes that can be moved and/or re-referenced. For example, creating the graphical menu within a pane and referencing it on every graphics page, therefore not rebuilding thus allowing for a single spot for updates that get pushed to all the pages that reference it.
n. The ability to create re-usable cascading menus.
o. The ability to have multiple instances of a graphic and edit one instance to change all.

3. Additionally, the Graphics Editor portion of the Engineering Software shall provide the following capabilities:
a. Create and save pages.
b. Group and ungroup symbols.
c. Modify an existing symbol.
d. Modify an existing graphic page.
e. Rotate and mirror a symbol.
f. Place a symbol on a page.
g. Place analog dynamic data in decimal format on a page.
h. Place binary dynamic data using state descriptors on a page.
i. Create motion through the use of animated .gif files or JavaScript.
j. Place test mode indication on a page.
k. Place manual mode indication on a page.
l. Place links using a fixed symbol or flyover on a page.
m. Links to other graphics.
n. Links to web sites.
o. Links to notes.
p. Links to time schedules.
q. Links to any .exe file on the operator work station.
r. Links to .doc files.
s. Assign a background color.
t. Assign a foreground color.
u. Place alarm indicators on a page.
v. Change symbol/text/value color as a function of an analog variable.
w. Change a symbol/text/value color as a function of a binary state.
x. Change symbol/text/value as a function of a binary state. .

l. The software shall allow for the automatic collection of data and reporting from any controller or NSC. The frequency of data collection shall be user-configurable.

J. Alarm Management
   1. The software shall be capable of accepting alarms directly from NSCs or controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.
   2. Alarm management features shall include:
      a. A minimum of 1000 alarm notification levels at the NSC, workstation, and webstation levels.
      b. Each notification level will establish a unique set of parameters for controlling alarm display, distribution, acknowledgment, keyboard annunciation, and record keeping.
      c. At the N4 Supervisor level the minimum number of active and viewable alarms shall be 10,000.
      d. It shall be possible for the user to sort, filter and search on any available criteria such as priority, category, origin, alarm type, etc.
      e. An active alarm viewer shall be included which can be customized for each user or user type to a hide or display any alarm attributes.
      f. It shall be possible to present alarms with configurable colors based on priority, category, origin, alarm type, etc.
      g. It shall be possible to linking files/documents/hyperlinks/navigation links/graphics link to an alarm for easy access upon occurrence
      h. Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of alarm, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement).
      i. Alarm notifications must support multiple distribution methods within one notification
      j. On alarm, it shall be possible to notify via email to a preconfigured list of recipients . through a Simple Mail Transfer Protocol (SMTP) or secure email using Simple Mail Transfer Protocol Secure (SMTPS). No special software interfaces shall be required and no email client software must be running in order for email to be distributed. The email notification shall be able to be sent to an individual user or a user group.
      k. On alarm, it shall be possible to notify via SNMP
      l. On alarm, it shall be possible to notify via file (on disk) that would be consumable by other alarm management services
      m. An operator shall have the capability to assign an alarm to another user of the system.
      n. Individual alarms shall be able to be assigned to a user automatically via a preconfigured list of users and date/time. For example, a critical high temp alarm can be configured to be assigned to a Facilities Dept or to a Central Alarming workstation depending on time/date.
      o. Playing an audible sound on alarm initiation or return to normal.
      p. It shall be possible assigning a custom audio sound to each alarm / alarm-criteria (priority, category, origin, alarm type, etc.)

q. The active alarm viewer can be configured such that an operator must confirm that all of the steps in a check list have been accomplished prior to acknowledging the alarm.
r. The active alarm viewer shall, if filtered, show the quantity of visible and total number of alarms that are not equal to 'normal' and the quantity of disabled and hidden alarms.
s. The alarm viewer can be configured to auto hide alarms when triggered.
t. An operator shall have the capability to save and apply alarm favorites.
u. Alarms shall be configurable such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms.
v. Alarms shall be configurable such that an operator must type in text in an alarm entry and/or pick from a drop-down list of causes for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.
w. It shall be possible to configure user-actions via user/group permissions when responding to an alarm
x. All operator actions responding to an alarm must be audit trailed.

K. Static Paginated Reporting / Custom Reporting
1. The BMS Software and Network Servers shall support built-in native reporting capability without dependency on any external software
2. It shall be possible to generate custom reports manually, via Schedule, Alarm triggered or custom conditions (e.g. program/schedule/etc.)
3. The Custom Reporting shall have no dependency on external database
4. The Custom Reporting shall have the capability of reporting on the full range of available data, most recent to historical data.
5. It shall be possible to generate reports containing current active alarms
6. The Building Management System software shall natively be capable of producing custom repots in txt, xlxs and pdf file formats.
7. The Custom Report capability at the BMS software shall support digital signing of pdf for traceability and authenticity.

L. Scheduling
1. From the workstation or webstation, it shall be possible to configure and download schedules for any of the controllers on the network.
2. Time of day schedules shall be in a calendar style and viewable in both a graphical and tabular view.
3. Schedules shall be programmable for a minimum of one year in advance.
4. To change the schedule for a particular day, a user shall simply select the day and make the desired modifications.
5. Additionally, from the operator webstations, each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.
6. Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.
7. It shall be possible to assign a lead schedule such that shadow/local schedules are updated based upon changes in the Lead.

8. It shall be possible to assign a list(s) of exception event days, dates, date ranges to a schedule.
9. It shall be possible to view combined views showing the calendar and all prioritized exemptions on one screen.
10. It should accommodate a minimum of 16 priority levels.
11. Values should be able to be controlled directly from a schedule, without the need for special program logic.

M. Programmer's Environment
1. Programming in the NSC shall be in graphical block format.
2. Programming of the NSC shall be available offline from system prior to deployment into the field. All engineering tasks shall be possible, except, of course, the viewing of live tasks or values.
3. The programmer's environment will include access to a superset of the same programming language supported in the SDCUs.
4. NSC devices will support a graphical function block programming language.
5. It shall be possible to save custom programs as libraries for reuse throughout the system. A wizard tool shall be available for loading programs from a library file in the program editor.
6. It shall be possible to view graphical programming live and real-time from the Workstation.
7. Key terms should appear when typing (IntelliType).
8. Applications should be able to be assigned different priorities and cycle times for a prioritized execution of different function.
9. The system shall be able to create objects that allow common objects such as power meters, VFD drives, etc. to be integrated into the system with simple import actions without the need of complicated programming or configuration setups.

N. Saving/Reloading
1. The workstation software shall have an application to save and restore NSC and field controller memory files.
2. For the NSC, this application shall not be limited to saving and reloading an entire controller – it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.

O. Audit Trail
1. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.
2. It shall be possible to view a history of alarms, user actions, and commands for any system object individually or at least the last 5000 records of all events for the entire system from Workstation.
3. The N4 Supervisor shall be able to store up to 5 million events.
4. The event view shall support viewing of up to 100,000 events.
5. It shall be possible to save custom filtered views of event information that are viewable and configurable in Workstation.

6. It shall be capable to search and view all forced values within the system.

P. Fault Tolerant N4 Supervisor Operation (Top level NSC)
   1. A single component failure in the system shall not cause the entire system to fail. All system users shall be informed of any detectable component failure via an alarm event. System users shall not be logged off as a result of a system failure or switchover.

Q. Web-based Operator Software
   1. General:
      a. Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network.
      b. The system shall be able to be accessed on site via a mobile device environment with, at a minimum, access to overwrite and view system values.
      c. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.
   2. Graphic Displays
      a. The browser-based interface must share the same graphical displays as the Administration and Programming Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser's graphics shall support commands to change setpoints, enable/disable equipment and start/stop equipment.
      b. Through the browser-based interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a record of the change stored in the system database.
      c. System shall have out-of-the-box dashboards that enable customizable views of live data which can be public to all users or capable to make them specific to a user based on log in credentials.
      d. The user shall have the ability to create custom dashboards.
      e. The dashboards shall have a kiosk mode which allows for occupant level data display on monitors or tablets throughout the building.
   3. Alarm Management
      a. Systems requiring additional client software to be installed on a PC for viewing the webstation from that PC will not be considered.
      b. Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented, if the user's password allows it. Users must be able to receive alarms, silence alarms, and acknowledge alarms through a browser. If desired, specific operator text must be able to be added to the alarm record before acknowledgement, attachments shall be viewable, and alarm checklists shall be available.

R. Groups and Schedules
   1. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.

2. Through the browser interface, operators must be able to change schedules – change start and stop times, add new times to a schedule, and modify calendars.

S. User Accounts and Audit Trail
1. The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.

T. All commands and user activity through the browser interface shall be recorded in the system's activity log, which can be later searched and retrieved by user, date, or both.

2.4 NETWORK SERVER CONTROLLERS (NSC: ALSO KNOWN AS JACE-8000)

A. Network Server Controllers shall combine both network routing functions, control functions, and server functions into a single unit.

B. The BACnet NSC shall be classified as a "native" BACnet device, supporting the BACnet Network Server Controller (B-BC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. NSCs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Network Server Controllers (B-BC).

C. The Network Server Controller shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NRS.

D. The NSCs shall be capable of whitelisting IPs to restrict access to a pre-defined list of hosts or devices.

E. Whitelisting of file extensions for documents shall be capable.

F. Encrypted and authenticated communication shall be configurable for non-open protocol communications using TLS 1.2.

G. The NSCs shall support Simple Network Management Protocol version 3 (SNMPv3) for monitoring of the NSCs using a Network Management Tool.

H. The NSCs shall support remote system logging for used by System Information and Event Monitoring (SIEM) software.

I. They shall also be responsible for monitoring and controlling their own HVAC equipment such as an AHU or boiler.

J. They shall also contain graphics, trends, trend charts, alarm views, and other similar presentation objects that can be served to workstations or web-based interfaces. A sufficient number of NSCs shall be supplied to fully meet the requirements of this specification and the attached point list.

K. It shall be capable of executing application control programs to provide:
1. Calendar functions

2. Scheduling
3. Trending
4. Alarm monitoring and routing
5. Time synchronization by means of an Internet site including automatic synchronization
6. Native integration of LonWorks controller data and Modbus controller data or BACnet controller data and Modbus controller data
7. Network Management functions for all LonWorks based devices

L. Hardware Specifications
   1. Memory:
      a. The operating system of the controller, application programs, and all other portions of the configuration database, shall be stored in non-volatile, FLASH memory. Servers/Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.
   2. Each JACE-8000 shall provide the following on-board hardware for communication:
      a. Two 10/100b Ethernet for communication to Workstations, other NRCs, IP field bus controllers, other SDCUs, and onto the internet.
         1) The two Ethernet ports shall support active switch and BACnet/IP communication protocols.
         2) Support IPv4 addressing
         3) Ethernet port 1 shall support static or DHCP client configuration for communication to Workstation or other NSCs
         4) Ethernet port 2 shall support switch mode or DHCP server to set addressing of DHCP client devices
         5) It shall be possible to disable Ethernet port 2
         6) In DHCP server mode, the Ethernet port 2 shall support 50 BACnet/IP field controllers in daisy chain configuration directly from the port
         7) Where a switch is needed, use an approved model from owner's information technology dept.
      b. Two RS-485 ports for communication to BACnet MSTP bus or serial Modbus (software configurable)
      c. One device USB port
      d. One host USB port
   3. The NSC shall conform to a small footprint no larger than 100W x 125H x 75D mm (3.94W x 4.92H x 2.95D in).

M. Modular Expandability:
   1. The system shall employ a modular I/O design to allow expansion. Input and output capacity is to be provided through plug-in modules of various types. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.
   2. One shall be able to "hot-change" (hot-swap) the I/O modules preserving the system on-line without any intervention on the software; addressing and configuration shall be automatic.

3. If for any reason the backplane of the modular I/O system were to fail, I/O module addresses will be protected.

N. Hardware Override Switches:
1. All digital outputs shall, optionally, include three position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall be built into the unit and shall provide feedback to the controller so that the position of the override switch can be obtained through software. In addition each analog output shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3 position manual override switch is placed in the ON position.

O. Universal Input Temperatures
1. All universal inputs directly connected to the NSC via modular expansion shall be capable of using the following thermistors for use in the system without any external converters needed.
   a. 10 kohm Type I
   b. 10 kohm Type II
   c. 10 kohm Type III
   d. 10 kohm Type IV
   e. Linearized 10 kohm Type V (FD w/11k shunt)
   f. Linearized 10 kohm
   g. 1.8 kohm
   h. 1 kohm
   i. 20 kohm
   j. 2.2 kohm
2. In addition to the above, the system shall be capable of using the below RTD sensors, however it is not required that all universal inputs be compatible with them.
   a. PT100
   b. PT1000
   c. Ni1000

P. Local Status Indicator Lamps:
1. The NSC shall provide as a minimum LED indication of CPU status, Ethernet LAN status, and field bus status. For each input or output, provide LED indication of the value of the point (On/Off). The LED indication shall support software configuration to set whether the illumination of the LED corresponds to On or Off or whether the color when illuminated is Red or Green.

Q. Real Time Clock (RTC):
1. Each NSC shall include a real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. Each NSC will allow for its own UTC offset, depending upon the time zone. When the time zone is set, the NSC will also store the appropriate times for daylight savings time.
2. The RTC date and time shall also be accurate, up to 10 days, when the NSC is powerless.
3. No batteries may be used to for the backup of the RTC.

R. Power Supply:
   1. The 24 VDC power supply for the NSCs shall provide 30 watts of available power for the NSC and associated IO modules. The system shall support the use of more than one power supply if heavily power consuming modules are required.
   2. The power supply, NSC, and I/O modules shall connect power wise and communication wise via the separate terminal base allowing for ease of replacement and no separate or loose wiring.

S. Automatic Restart After Power Failure:
   1. Upon restoration of power after an outage, the NSC shall automatically and without human intervention update all monitored functions, resume operation based on current, synchronize time and status, and implement special start-up strategies as required.

T. Data Retention:
   1. During a power failure, the NSC shall retain all programs, configuration data, historical data, and all other data that is configured to be retained. There shall be no time restriction for this retention and it must not use batteries to achieve it.

U. Software Specifications
   1. The operating system of the controller, application programs, and all other portions of the configuration database such as graphics, trends, alarms, views, etc., shall be stored in non-volatile, FLASH memory. There will be no restrictions placed on the type of application programs in the system. Each NSC shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
   2. Each NSC shall have an available capacity of 4 GB of memory. This shall represent 2 GB for application and historical data and 2 GB dedicated for backup storage.

V. User Programming Language:
   1. The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be either a script-based structured text or graphical function block based and fully programmable by the user. The language shall be structured to allow for the configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, and histories. Users shall be able to place comments anywhere in the body of either script or function block programs.
   2. Network Server Controllers that use a “canned” program method will not be accepted.

W. Control Software:
   1. The NSC shall have the ability to perform the following pre-tested control algorithms:
      a. Proportional, Integral plus Derivative Control (PID)

b. Two Position Control
c. Digital Filter
d. Ratio Calculator
e. Equipment Cycling Protection

X. Mathematical Functions:
1. Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.

Y. NSCs shall have the ability to perform any or all of the following energy management routines:
1. Time of Day Scheduling
2. Calendar Based Scheduling
3. Holiday Scheduling
4. Temporary Schedule Overrides
5. Optimal Start
6. Optimal Stop
7. Night Setback Control
8. Enthalpy Switchover (Economizer)
9. Peak Demand Limiting
10. Temperature Compensated Duty Cycling
11. CFM Tracking
12. Heating/Cooling Interlock
13. Hot/Cold Deck Reset
14. Hot Water Reset
15. Chilled Water Reset
16. Condenser Water Reset
17. Chiller Sequencing

Z. History Logging:
1. Each NSC controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable either over user defined time intervals ranging from 1 second to 1440 minutes or based upon a user configurable change of value. A minimum of 1000 logs, with a minimum of 100,000 records, shall be stored. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to a higher level NSC long term archiving based upon user-defined time intervals, or manual command.
2. For extended trend logging a minimum of 1500 trends shall be capable, with a minimum number of 600,000 records within.
3. Management of a power meter replacement to ensure meter log data is accurate shall be possible in the NSC.

4. Every hardware input and output point, hosted within the NSC and attached I/O modules, shall be trended automatically without the requirement for manual creation, and each of these logs shall log values based upon a change of value and store at least 500 trend samples before replacing the oldest sample with new data.
5. The presentation of logged data shall be built into the server capabilities of the NSC. Presentation can be in time stamped list formats or in a chart format with fully configurable pen colors, weights, scales and time spans.
6. Tooltips shall be present, magnetic, and visible based on users preference.
7. Comments shall be visible whenever viewing the trend log list.
8. System shall give indication of memory usage and be able to alert the user if too many logs are allocated.
9. The BMS software and Network Servers shall support recording of all historical data, independent of any limitation in its local memory, which will be readily available for reporting and analysis without additional configurations or actions.
10. All historical data shall be available for use by the operator to access in BMS or a third-party reporting systems.

AA. Alarm Management:
1. For each system point, alarms can be created based on high/low limits or in comparison to other point values. All alarms will be tested each scan of the NSC and can result in the display of one or more alarm messages or reports.
2. There is no limit to the number of alarms that can be created for any point
3. Alarms can be configured to be generated based upon a single system condition or multiple system conditions.
4. Alarms will be generated based on an evaluation of the alarm conditions and can be presented to the user in a fully configurable order, by priority, by time, by category, etc. These configurable alarm views will be presented to a user upon logging into the system regardless of whether the log in takes place at a WorkStation or a Webstation.
5. The alarm management system shall support the ability to create and select cause and action notes to be selected and associated with an alarm event. Checklists shall also be possible in order to present to an operator a suggested mode of troubleshooting. When acknowledging an alarm, it shall be possible to assign it to a user of the system such that the user is notified of the assignment and is made responsible for the alarm resolution.
6. Alarms must be capable of being routed to any BACnet workstation that conforms to the B-OWS device profile and uses the BACnet/IP protocol.

BB. Embedded Web Server
1. Each NSC must have the ability to serve out web pages containing the same information that is available from the WorkStation. The development of the screens to accomplish shall not require any additional engineering labor over that required to show them at the WorkStation itself.
2. The NSC shall be configurable to logging all Embedded Web Server access attempts
3. The NSC shall have the option to redirect HTTP based Embedded Web Server connections to secure, HTTPS connections.

4. The NSC shall authenticate and authorize all users connecting to the Embedded Web Server
5. The NSC shall provide to ability to configure an automatic logoff for Embedded Web Server users that have not had any activity for an adjustable time period.

CC. The NSC controller shall comply with the following regulatory certifications
1. CE – EN 61000-6-3
2. CE – EN 61000-6-2
3. CE – EN 61010-1
4. CE – EN 61326-1
5. FCC CFR 47 Part 15 Class A
6. RCM
7. RoHS 2011/65/EU
8. China RoHS SJ/T 11364-2014
9. UL916 Energy Management equipment

DD. HMI
1. The NSC shall have an option for a tablet display
2. The tablet display shall be an industrial grade Human Machine Interface (HMI) that can be locked to the building management application to create a dedicated tool for local operation and maintenance.
3. The tablet display shall provide an easy-to-use interface through which users and engineers can locally access NSC's
4. The tablet display shall always start in a kiosk mode ensuring the end user can only use the device using the installed integration with the NSC.
5. The tablet display shall always require a password on start up
6. The tablet display shall require a password after a defined period of inactivity
7. The tablet display shall support being handheld or being installed on a control cabinet.
8. The tablet display user interface shall provide touchscreen navigation making it easy to operate and maintain the system.
9. The tablet display shall support robust physical panel mounting mechanisms provided with the product.
10. The tablet display shall have a screen size of 255mm or 10.1 inches
11. The tablet display shall support a screen resolution of 1280 by 800 pixels
12. The tablet display shall have a 16:10 aspect ratio
13. The tablet display shall be based on the Android platform
14. The tablet display shall have an IP54 rated frame that helps protect against dust and moisture.
15. The tablet display shall be powered by a 24 VDC power supply
16. The tablet display can be powered by a 24 VDC through the Y-shaped cable
17. The tablet display shall be able to communicate with the NSC over a wired (USB) connection running BACnet IP over USB.
18. The tablet display shall have an accessory Wi-Fi Module is an option instead of using USB for communication.
    a. Through the Wi-Fi module, you can establish wireless communication between the tablet display and the NCS connected to a wireless access point.
    b. The Wi-Fi module shall have an adhesive mount Wi-Fi antenna.

c. The Wi-Fi module shall be compliant with IEEE 802.11 b/g/n
d. The Wi-Fi module shall support enhanced wireless security using 64-bit and 128-bit WEP encryption

19. The tablet display shall connect to the NSC using only secure, HTTPS connections via the WebStation functionality of the NSC
20. The tablet display shall connect using a specific user and password combination defined as part of the NSC configuration

2.5 BACNET IP FIELDBUS CONTROLLERS

A. Controllers – BACnet/IP Protocol
1. All BACnet/IP Fieldbus controllers shall be BACnet Testing Laboratory listed (v12 or later) as specified BACnet Advanced Application Controller (B-AAC)
2. All BACnet/IP Fieldbus controllers shall use the following communication specifications and achieve performance as specified herein:
a. All controllers shall be able to communicate peer-to-peer without the need for a NSC
b. Any BACnet/IP Fieldbus controllers on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.

B. The BACnet/IP Fieldbus controllers shall be equipped with 2x 10/100bT Ethernet communication ports with active switch and will support BACnet/IP communication protocols with the following configurations:
1. Supporting IPv4 addressing
2. Supporting Static IP setting, DHCP client and Auto-IP address acquisition
3. It shall be possible to disable Ethernet port 2

C. Topologies
1. BACnet/IP Fieldbus controllers shall support daisy chain topology of up to 50 controllers. In case of any disruption to the communication, a system alarm shall notify the NSC/BMS of the point disruption has occurred.
2. BACnet/IP Fieldbus Controllers shall support RSTP loop whereby up to 39 controllers are supported.
a. In case of any disruption there shall be no communication interruption
b. In case of any disruption there shall be system alarms that will inform the operator of the disruption

D. Performance
1. Each BACnet/IP Fieldbus Controllers shall have a 32-bit microprocessor operating at 500 MHz and support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135-2008 and the BACnet Device Profile supported.
2. They shall be multi-tasking, real-time digital control processors consisting of communication controllers, controls processing, power supplies with built-in inputs and outputs.

E. Programmability
   1. The BACnet/IP Fieldbus controllers shall support both script programming language and graphical that will be consistent with the NSC.
   2. The control program will reside within the same enclosure as the input/output circuitry, that reads inputs and controls outputs
   3. All control sequences programmed into the BACnet/IP Fieldbus Controllers shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
   4. BACnet/IP Fieldbus controllers shall communicate with the Network Server Controller (NSC) via a BACnet/IP connection at a baud rate of not less than 100 Mbps
   5. BACnet/IP Fieldbus controllers shall support a dedicated communications port for connecting and supplying power to a matching room temperature and/or humidity sensor and/or CO2 and/or presence detector that does not utilize any of the I/O points of the controller.
   6. BACnet/IP Fieldbus controllers (Excluding VAV) shall support an add-on display to supply and provide access in real-time for monitoring inputs and overriding of outputs
   7. The override functionality must be supported by a dedicated processor to assure reliable operation (overriding of output)
   8. Each BACnet/IP Fieldbus controller shall have sufficient memory, to support its own operating system and databases, including:
      a. Control processes
      b. Energy management applications
      c. Alarm management
      d. Historical/trend data
      e. Maintenance support applications
      f. Custom processes
      g. Manal override monitoring
   9. Each BACnet/IP Fieldbus controller shall support local trend data up to 2x the built-in I/O and at a minimum be capable of holding 5 days @ 15 min intervals locally.
   10. The BACnet/IP Fieldbus controller analog or universal input shall use a 16 bit A/D converter.
   11. The BACnet/IP Fieldbus controller analog or universal output shall use a 10 bit D/A converter.
   12. Built-in I/O: each BACnet/IP Fieldbus controllers shall support:
      a. At minimum 8 and up to 20 configurable IO channels to monitor and to control the following types of inputs and outputs without the addition of equipment inside or outside the DDC Controller cabinet.
         1) Universal Inputs – the following thermistors for use in the system without any external converters needed.
            a) 10 kohm Type I
            b) 10 kohm Type II
            c) 10 kohm Type III
            d) 10 kohm Type IV
            e) Linearized 10 kohm Type V (FD w/11k shunt)
            f) Linearized 10 kohm
            g) 1.8 kohm

h) 1 kohm
i) 20 kohm
j) 2.2 kohm
k) PT100
l) PT1000
m) Ni1000

2) Analog inputs
a) Current Input - 0-20 mA
b) Voltage Input 0-10 Vdc

3) Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
4) Digital outputs
5) Analog outputs of 4-20 mA and/or 0-10 Vdc

13. Real Time Clock (RTC):
    a. Provide internal clocks for all BACnet Controllers (B-AAC) using BACnet time synchronization services.
        1) Automatically synchronize system clocks daily from an operator-designated controller.
        2) The system shall automatically adjust for daylight saving time.
    b. Each BACnet/IP Fieldbus controller shall include a real time clock, accurate to +/-1 minute per month.
    c. The RTC shall provide the following: time of day, day, month, year, and day of week.
    d. The RTC date and time shall also be accurate up to 7 days, from when the BACnet/IP Fieldbus controller has lost power with no reliance on.
14. The BACnet/IP Fieldbus controller for Variable Air Volume (VAV) applications
    a. The BACnet/IP Fieldbus controller for VAV applications shall include a built-in ‘flow thru’ differential pressure transducer
    b. The VAV differential pressure transducer shall have a measurement range of 0 to 1 in. W.C. and measurement accuracy of ±5% at 0.001 to 1 in. W.C. and a minimum resolution of 0.001 in. W.C., insuring primary air flow conditions shall be controlled and maintained to within ±5% of setpoint at the specified minimum and maximum air flow parameters
    c. The BACnet/IP FieldBus controller for VAV applications shall support a dedicated commissioning tool for air flow balancing
    d. The BACnet/IP Fieldbus controller for VAV applications shall require no programing for air balancing algorithm
    e. All balancing parameters shall be synchronized in NSC
15. Each BACnet/IP Fieldbus controller shall have a minimum of 10% spare capacity for each point type represented on the controller for future point connection
16. Power Requirements. 24VDC (21 to 33 VDC) and 24 VAC +/-20% with local transformer power
17. The BACnet/IP Fieldbus controller shall comply with the following regulatory certifications
    a. CE - EMCD 2014/30/EU
    b. CE LVD 2014/35/EU
    c. FCC CFR 47 Part 15 Class B
    d. RCM
    e. RoHS 2011/65/EU

f. China RoHS SJ/T 11364-2014
g. UL2043 (Plenum space mounting)
h. UL916 Open-Energy Management equipment
i. UL916 Energy Management equipment

18. Intelligent Space Sensor Interface –
    a. The BACnet/IP Fieldbus controllers shall support a dedicated RJ45 communication port to communicate and power up to 4 intelligent wall mount sensors without the use of on-board inputs or outputs
    b. It shall be possible to disable the RJ45 communication port.
19. The BACnet/IP Fieldbus controller for Connected Room solutions
    a. All BACnet/IP Fieldbus controllers shall be BACnet Testing Laboratory listed (v14 or later) as specified BACnet Advanced Application Controller (B-AAC)
    b. All BACnet/IP Fieldbus controllers shall use the following communication specifications and achieve performance as specified herein:
        1) All controllers shall be able to communicate peer-to-peer without the need for an NSC
        2) Any BACnet/IP Fieldbus controllers on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.
    c. The BACnet/IP Fieldbus controllers shall be equipped with 2x 10/100bT Ethernet communication ports with active switch and will support BACnet/IP communication protocols with the following configurations:
        1) Supporting IPv4 addressing
        2) Supporting Static IP setting, DHCP client and Auto-IP address acquisition
        3) It shall be possible to disable Ethernet port 2
        4) Each BACnet/IP controller shall be configurable to restrict communications to only whitelisted IP addresses.
    d. Topologies
        1) BACnet/IP Fieldbus controllers shall support daisy chain topology of up to 50 controllers. In case of any disruption to the communication, a system alarm shall notify the NSC/BMS of the point disruption has occurred.
        2) BACnet/IP Fieldbus Controllers shall support RSTP loop whereby up to 39 controllers are supported.
            a) In case of any disruption there shall be no communication interruption
            b) In case of any disruption there shall be system alarms that will inform the operator of the disruption
    e. Performance
        1) Each BACnet/IP Fieldbus Controllers shall have a 32-bit microprocessor operating at 500 MHz and support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135-2012 and the BACnet Device Profile supported.

2) They shall be multi-tasking, real-time digital control processors consisting of communication controllers, controls processing, power supplies with built-in inputs and outputs.
3) Each BACnet/IP Fieldbus Controllers shall support upgrade of its firmware with no impact to its operation

f. Programmability
1) The BACnet/IP Fieldbus controllers shall support graphical programming that will be consistent with the NSC.
2) The control program will reside within the same enclosure as the input/output circuitry, that reads inputs and controls outputs
3) All control sequences programmed into the BACnet/IP Fieldbus Controllers shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
4) The BACnet/IP Fieldbus controllers shall communicate with the Network Server Controller (NSC) via a BACnet/IP connection at a baud rate of not less than 100 Mbps
5) The BACnet/IP Fieldbus controllers shall support two RS485 communication ports for connecting and supplying power to a range of protocol types
a) BACnet/IP Fieldbus controllers shall support configurable selection of the supported protocol on the RS485 communications ports,
b) BACnet/IP Fieldbus controllers shall support a communications capability for connecting and supplying power to a matching room temperature and/or humidity sensor and/or CO2 and/or presence detector that does not utilize any of the I/O points of the controller.
c) BACnet/IP Fieldbus controllers shall support a communications capability for connecting and supplying power to a matching connected module for the purpose of control of lights and blinds that do not utilize any of the I/O points of the controller
d) BACnet/IP Fieldbus controllers shall support a communications capability for connecting to open market Modbus devices

g. Each BACnet/IP Fieldbus controller shall have sufficient memory, to support its own operating system and databases, including:
1) Control processes
2) Energy management applications
3) Alarm management
4) Historical/trend data
5) Maintenance support applications
6) Custom processes

h. In the case of communication disruption between the BACnet/IP Fieldbus controller and NSC/BMS, each BACnet/IP Fieldbus controller shall support storage of local trend data up to 2x the number of its built-in I/O at the collection rate of 5 min for 5 days.

i. The BACnet/IP Fieldbus controller analog or universal input shall use a 16-bit A/D converter.

j. The BACnet/IP Fieldbus controller analog or universal output shall use a 10-bit D/A converter.

k. Built-in I/O: each BACnet/IP Fieldbus controllers shall support:
   1) Up to 8 configurable IO channels to monitor and to control the following types of inputs and outputs without the addition of equipment inside or outside the DDC Controller cabinet.
      a) Universal Inputs – the following thermistors for use in the system without any external converters needed.
      b) 10K Ohm Type I
      c) 10K Ohm Type II
      d) 10K Ohm Type III
      e) 10K Ohm Type IV
      f) Linearized 10K Ohm Type V (FD w/11k shunt)
      g) Linearized 10K Ohm
      h) 1.8K Ohm
      i) 1K Ohm
      j) 20K Ohm
      k) 2.2K Ohm
      l) PT100
      m) PT1000
      n) Ni1000 ,
      o) Voltage Input - 0-10 Vdc
      p) Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
      q) Digital outputs
      r) Analog outputs 0-10 Vdc
l. Internal Clock
   1) Provide internal clocks for all BACnet Controllers (B-AAC) using BACnet time synchronization services.
      a) Automatically synchronize system clocks daily from an operator-designated controller.
      b) The system shall automatically adjust for daylight saving time.
   2) Each BACnet/IP Fieldbus controller shall include a real time clock, accurate to +/-1 minute per month.
   3) The RTC shall provide the following: time of day, day, month, year, and day of week.
   4) The RTC date and time shall also be accurate up to 7 days, from when the BACnet/IP Fieldbus controller has lost power with no reliance on batteries
m. Each BACnet/IP Fieldbus controller shall have a minimum of 10% spare capacity for each point type represented on the controller for future point connection
n. Power Requirements. 24VDC (21 to 33 VDC) and 24 VAC +/-20% with local transformer power
o. Power Requirements. A line voltage version shall be available 230 VAC
p. In the case of power disruption, each BACnet/IP Fieldbus controller shall support power failure recovery within 10 seconds and resume operation from where the disruption had occurred
q. The BACnet/IP Fieldbus controller shall be able to be plenum mounted (UL2043 compliant)

r. The BACnet/IP Fieldbus controller shall meet the open class standard of UL916 permitting its installation without secondary enclosure where appropriate
s. The BACnet/IP Fieldbus controller shall comply with the following regulatory certifications
    1) CE - EMCD 2014/30/EU
    2) CE LVD 2014/35/EU
    3) FCC CFR 47 Part 15 Class B
    4) RCM
    5) RoHS 2011/65/EU
    6) China RoHS SJ/T 11364-2014
    7) UL2043 (Plenum space mounting)
    8) UL916 Open-Energy Management equipment
    9) UL916 Energy Management equipment
t. Intelligent Space Sensor Interface - The BACnet/IP Fieldbus controllers shall support an RJ45 communication port to communicate and power up to 4 intelligent wall mount sensors without the use of on-board inputs or outputs
    1) It shall be possible to disable the RJ45 communication port

20. The BACnet/IP Fieldbus controller for remote IO
    a. It shall be possible to extend Inputs / Outputs required in NSC or BACnet/IP Fieldbus Controllers over the IP network
    b. The BACnet/IP IO expansion device shall be equipped with 2x 10/100bT Ethernet communication ports with active switch supporting the following configurations:
        1) Supporting IPv4 addressing
        2) Supporting Static IP setting, DHCP client and Auto-IP address acquisition
        3) It shall be possible to disable Ethernet port 2
    c. The BACnet/IP IO expansion device shall support daisy and RSTP topologies
    d. The BACnet/IP I/O expansion device shall be capable of sharing its local I/O resources with one or multiple applications distributed across one or multiple NSCs or BACnet/IP Fieldbus Controllers.
    e. The BACnet/IP I/O expansion device shall support BACnet Alarm and Trend locally
    f. Outputs of the BACnet/IP I/O expansion device shall support user configurable fallback value that is triggered in case of communication disruption.

F. The Intelligent Space Sensor shall be capable of displaying measured space temperature from 0 to 50 °C (32 to 122 °F) with accuracy of ±0.2 °C (±0.4 °F) selectable for 0.1 or 1 degree display resolution of °F or °C
    1. Sensing Element: 10k Type 3 Thermistor
    2. Accuracy of ±0.2 °C (±0.4 °F)
    3. Resolution: 0.1 or 1 degree display resolution
    4. Range: 0 to 50 °C (32 to 122 °F)

G. The Intelligent Space Sensor shall have the option for humidity sensor support sensing humidity from 0 % RH to 100 % RH Digital humidity indication (selectable for 0.1 or 1% RH with selectable display resolution of 0.1 or 1 % RH
   1. Accuracy: ±2 % RH
   2. Resolution: 0.1 or 1 % RH
   3. Range: 0 % RH to 100 % RH

H. The Intelligent Space Sensor shall have the option for support of CO2 sensor with display resolution with 0 to 2000 ppm resolution
   1. Accuracy: ±30 ppm ±2% of measured value
   2. Range: 0 to 2,000 ppm
   3. Operating elevation: 0 to 16,000 ft.
   4. Temperature dependence: 0.11% FS per ˚F
   5. Stability: <2% of FS over life of sensor (15 years)
   6. Sensing method: Non-dispersive infrared (NDIR), diffusion sampling

I. The Intelligent Space Sensor shall have the option for motion sensor

J. Display options: The Intelligent Space Sensor shall be capable of displaying the following elements:
   1. Space temperature
   2. Cooling space temperature set point
   3. Heating space temperature set point
   4. Current heating or cooling mode
   5. Current occupancy mode
   6. Fan speed
   7. Current time

2.6 BACNET FIELDBUS AND BACNET SDCUS

A. Networking
   1. IP Network: All devices that connect to the WAN shall be capable of operating at 10 megabits per second or 100 megabits per second.
   2. IP To Field Bus Routing Devices
      a. A Network Server Controller shall be used to provide this functionality.
      b. These devices shall be configurable locally with IP crossover cable and configurable via the IP network.
      c. The routing configuration shall be such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.

B. Field Bus Wiring and Termination
   1. The wiring of components shall use a bus or daisy chain concept with no tees, stubs, or free topology.
   2. Each field bus shall have a termination resistor at both ends of each segment.
   3. The field bus shall support the use of wireless communications.

C. Repeaters
   1. Repeaters are required to connect two segments.

2. Repeaters shall be installed in an enclosure. The enclosure may be in an interstitial space.

D. Field Bus Devices
   1. General Requirements
      a. Devices shall have a light indicating that they are powered.
      b. Devices shall be locally powered. Link powered devices (power is furnished from a central source over the field bus cable) are not acceptable.
      c. Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings. (Battery backup, flash memory, etc.)

E. Advance Application Controllers (B-AAC)
   1. The key characteristics of a B-AAC are:
      a. They have physical input and output circuits for the connection of analog input devices, binary input devices, pulse input devices, analog output devices, and binary output devices. The number and type of input and output devices supported will vary by model.
      b. They may or may not provide support for additional input and output devices beyond the number of circuits that are provided on the basic circuit board. Support for additional I/O shall be provided by additional circuit boards that physically connect to the basic controller.
      c. The application to be executed by a B-AAC is created by an application engineer using the vendor's application programming tool.
      d. If local time schedules are embedded, the B-AAC shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.
      e. If local trend logging is embedded, the B-AAC shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.
      f. If local alarm message initiation is embedded, the B-AAC shall:
         1) Deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient off the alarm message.
         2) Support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement,
      g. Shall support the reading of analog and binary data from any BACnet OWS or Building Controller that supports the BACnet service for the reading of data.
      h. Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.
      i. Shall support the receipt and response to Time Synchronization commands from a BACnet Building Controller.
      j. Shall support the "Who is" and "I am." BACnet services.
      k. Shall support the "Who has" and "I have." BACnet services.

2. Analog Input Circuits
   a. The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.
   b. For non-flow sensors, the control logic shall provide support for the use of a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).
   c. For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).
   d. For non-linear sensors such as thermistors and flow sensors the B-AAC shall provide software support for the linearization of the input signal.
3. Binary Input Circuits
   a. Dry contact sensors shall wire to the controller with two wires.
   b. An external power supply in the sensor circuit shall not be required.
4. Pulse Input Circuits
   a. Pulse input sensors shall wire to the controller with two wires.
   b. An external power supply in the sensor circuit shall not be required.
   c. The pulse input circuit shall be able to process up to 20 pulses per second.
5. True Analog Output Circuits
   a. The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliamps or 0 to 20 milliamps or to ranges within the full output range (Example: 0 to 100% creates 3 to 6 VDC where the full output range is 0 to 10 VDC).
   b. The resolution of the D/A chip shall not be greater than 0.04 Volts per increment or 0.08 milliamps per increment.
6. Binary Output Circuits
   a. Single pole, single throw or single pole, double throw relays with support for up to 230 VAC and a maximum current of 2 amps.
   b. Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.5 amps at 24 VAC.
7. Program Execution
   a. Process control loops shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
   b. The sample rate for a process control loop shall be adjustable and shall support a minimum sample rate of 1 second.
   c. The sample rate for process variables shall be adjustable and shall support a minimum sample rate of 1 second.
   d. The sample rate for algorithm updates shall be adjustable and shall support a minimum sample rate of 1 second.
   e. The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of a power cycle to modify the sequence of controller immediately following a power cycle.

8. Local Interface
   a. The controller shall support the connection of a portable interface device such as a laptop computer or vendor unique hand-held device. The ability to execute any tasks other than viewing data shall be password protected. Via this local interface, an operator shall be able to:
      1) Adjust application parameters.
      2) Execute manual control of input and output points.
      3) View dynamic data.

F. Application Specific Devices
1. Application specific devices shall have fixed function configurable applications.
2. If the application can be altered by the vendor's application programmable tool, the device is an advanced application controller and not an application specific device.
3. Application specific devices shall be BTL certified.

G. Room controllers
1. For connected room solutions that do not require integrated lighting and blind busses built into a singular unit, the system shall include a BACnet MS-TP enabled controller specifically designed for room control.
2. The controller shall communicate via BACnet MS-TP. It should also be capable of MODBUS RTU communication.
3. The controller shall be capable of controlling fan coil units, cooling VVT zones with reheat, fin-tube radiators, cabinet heaters, radiant panel heaters, electric re-heat zones, terminal reheats, rooftop units (1H1C, 2H2C, 3H2C, MH2C), or heat pumps, if necessary.
4. The controller shall house an onboard temperature sensor, and options for onboard humidity and occupancy sensor.
5. The controller shall utilize a touch screen interface and have multiple options for casings and fascias. The screen shall be a TFT transmissive LED backlit LCD touchscreen with at least 5 color options.
6. Controller will have password protection to prevent unauthorized access to the configuration menu parameters.
7. The controller will have integrated Zigbee wireless communications with predefined profiles for Zigbee door and window switches, occupancy sensors, water leakage detectors, CO2 sensors, and additional temperature and humidity sensors.
8. The controller will be capable of hosting at least 10 Zigbee sub devices.
9. The controller will be capable of being programmed with customizable scripts via the open programming language Lua. It shall be equipped with at least 256KB of SRAM with 80KB configurable/reserved for Lua scripting purposes.

2.7 ELECTRONIC SENSORS

A. DESCRIPTION
1. Vibration and corrosion resistant, for wall, immersion, or duct mounting as required.
2. All sensors provided with a guard or cover shall submit color samples to the Architect before ordering sensors.

3. Room Sensor Cover Construction: Manufacturer's standard locking covers. This applies to all wall mounted sensors.
   a. Color: Submit color selection to Architect prior to ordering.
   b. Orientation: Vertical
   c. Appearance: standard
   d. Housing: Plastic
4. Room sensor accessories include the following:
   a. Insulating Base: For sensors located on exterior walls and cold surfaces.
   b. Adjusting Device: As required for calibration and cover screws.

B. THERMISTORS
1. Manufacturers:
   a. MINCO.
   b. MAMAC Systems.
   c. RDF Corporation.
2. Sensor type and accuracy:
   a. Negative temperature coefficient (NTC) sensor with 10K-ohms or less resistance.
3. Wiring requirement: Twisted, shielded-pair cable.
4. Accuracy: Plus or minus 0.5-degrees F at calibration point.
5. Wiring requirement: Twisted, shielded-pair cable.
6. Insertion Elements in Ducts: Single point, 8-inches long; use where not affected by temperature stratification or where ducts are smaller than 9-sq. ft..
7. Averaging Elements in Ducts: 72- inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10-sq. ft..
8. Insertion Elements for Liquids: Brass well (for copper, brass, or plastic pipe) with minimum insertion length of 2-1/2-inches. Stainless steel well for ferrous pipe.
9. Outside Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
10. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

C. RTD AND TRANSMITTERS
   a. MINCO.
   b. MAMAC Systems.
   c. RDF Corporation.
2. Sensor element:
   a. Platinum.
   b. Nickel.
3. Accuracy: Plus or minus 0.5-degrees F at calibration point.
4. Wiring requirement: Twisted, shielded-pair cable.
5. Insertion Elements in Ducts: Single point, 8-inches long; use where not affected by temperature stratification or where ducts are smaller than 9-sq. ft..
6. Averaging Elements in Ducts: 24- inches long, rigid; use where prone to temperature stratification or where ducts are larger than 9-sq. ft.; length as required.
7. Insertion Elements for Liquids: Brass well (for copper or brass pipe) with minimum insertion length of 2-1/2-inches. Stainless steel well for ferrous pipe.
8. Outside Air Sensors: Watertight, electrical inlet fitting; sensors are shielded from direct sunlight.

9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
10. Transmitter output shall be 4- to 20-mA, nominal 24-V dc. Output impedance must meet DDC input requirements.

D. PRESSURE TRANSMITTERS/TRANSDUCERS
1. Manufacturers:
   a. BEC Controls.
   b. General Electric. (General Eastern Instruments)
   c. MAMAC Systems.
   d. Rotronic Instrument Corp.
   e. Setra Systems.
   f. TCS/Basys Controls.
   g. Vaisala.
2. Sensors: Appropriate sensing chamber for medium being sensed.
3. Wiring requirement: twisted, shielded-pair cable for wiring unless specified otherwise by the manufacturer.
4. Air Static Pressure Transmitter: Non-directional sensor with suitable range for expected input, and temperature compensated.
   a. Accuracy: 2-% full scale with repeatability of 0.5 percent.
   b. Output: 4- to 20-mA. Output impedance must meet input requirements.
   c. Building Static Pressure Range: Minus 0.05- to 0.05-inches wg.
   d. Duct Static Pressure Range: 0- to 2.5-inches wg.
5. Hydronic Pressure Transducers: Stainless steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output.
   a. Accuracy: 2-% FS scale reading with repeatability of 0.5-% FS
   b. Output: 4- to 20-mA, nominal 24-V dc. Output impedance must meet input requirements.
   c. Range: 0-to 60-psig.
6. Hydronic Differential Pressure Transducers: Stainless steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output. Provide 3-valve manifold with instrument.
   a. Accuracy: 1-% FS overall accuracy: includes sensor accuracy, linearity, hysteresis, and non-repeatability.
   b. Output: 4- to 20-mA, nominal 24-V dc, loop- powered. Output impedance must meet DDC input requirements.
   c. Range: 0-to 60-psig.
7. Air Differential Pressure Switch: Snap acting, pilot-duty rated contact, and with suitable scale range and setting adjustment.
   a. SPDT or DPDT, dry contact style device
   b. Range: Adjustable from 1- to 10- inches wg
   c. Differential: Adjustable from 2-psig to 10-psig
8. Air Differential Pressure Switch: Snap acting, pilot-duty rated contact, and with suitable scale range and setting adjustment.
   a. SPDT or DPDT, dry contact style device
   b. Range: Adjustable from 1- to 10- inches wg (249- to 2490-Pa)
   c. Differential: Adjustable from 0.1- to 0.25-inches wg (25- to 62-Pa)

9. Process Pressure and Differential Pressure Transmitters: Direct acting for gas or steam service; range suitable for system; linear output.
    a. Accuracy: 1-% FS with repeatability of 0.5-% FS.
    b. Output: 4- to 20-mA, nominal 24-V dc, loop-powered. Output impedance must meet DDC input requirements.
    c. Air Pressure Range: 0-to 100-psig.
    d. Velocity Pressure Range: 0- to 0.5-inches wg.
    e. Add vacuum pressure sensors if required in project.

2.8 STATUS SENSORS AND DEVICES - ELECTRIC

A. Status Input for Fan: Differential pressure switch with pilot-duty rated contacts and adjustable range of 0- to 5-inch wg.
    1. Manufacturers:
        a. Cleveland Controls.

B. Sensing Inputs for Electric Motors:
    1. Manufacturers:
        a. American Aerospace Controls.
    2. Current Transformer/Transmitter: Comply with ISA 50.00.01, current-sensing, fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current and 1 percent full-scale accuracy, for AC or DC applications.
    3. Voltage Transformer/Transmitter (100- to 600-V AC): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy, for AC or DC applications.
    4. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor, for AC and DC applications.

C. Current Switch: Self-powered, current-sensing, split-core, solid-state devices with adjustable trip current and indicating LED, selected to match motor current and DDC input requirements.
    1. Manufacturers:
        a. Nielsen-Kuljian.
        b. Veris Industries.

D. Liquid Leak Detectors
    1. Liquid detectors shall utilize microchip technology for detection of conductive liquids through one of the following types of sensors: gold-plated probes, self-adhesive sensor tape with copper electrodes and durable cotton cover, or rope type sensor. Detectors shall be selected based on the best use for the application. Power requirement shall be 11-27 VAC or VDC and have a green LED normal operation indicator. Unit shall have a SPDT pilot duty low voltage alarm contact. Unit shall be waterproof and rustproof. A red LED shall indicate the presence of liquid. Unit shall have an adjustable setpoint.
    2. Approved Manufacturers:
        a. R. E. Technologies.

b. Dorlen Products. (Water Alert)

E. Control Relay: Monitors or controls AC or DC motors or other equipment (as required), with cover, with visual indicator when energized, and two SPDT contacts rated 120/250 VAC at 8 Amps.
1. Manufacturers:
a. Dayton.
b. Omron.
c. Functional Devices.

2.9 GAS DETECTION EQUIPMENT

A. Carbon Dioxide Sensor:
1. Manufacturers:
a. General Eastern. (General Electric)
b. MSA Canada.
c. Telaire.
d. TSI Incorporated.
e. Vaisala.
f. Valtronics.
2. Sensor element:
a. Sensor range shall be 0- to 2000-ppm
b. Single detector using solid-state, non-dispersive, infrared (NDIR) sensor.
c. Suitable for operation over a temperature range of 23- to 130-degrees F for outside air; a temperature range of 32- to 104-degrees Falibrated for 4 percent of full scale accuracy, with continuous or averaged reading.
3. Accuracy: Plus or minus 50-ppm CO2 at calibration point. Accuracy includes hysteresis, repeatability, and yearly drift values.
4. Wiring requirement: Twisted, shielded-pair cable.
5. Insertion Elements in Ducts: Provide template for cutting or drilling ductwork for mounting holes.
6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
a. Setpoint Adjustment: None
b. Display: Concealed LED
c. Color: color from manufacturer's full range.
d. Orientation: Vertical.
7. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

2.10 Transmitter output: 4- to 20-mA, nominal 24-V dc; loop-powered, compatible with DDC system input impedance.

2.11 OCCUPANCY, DAYLIGHTING, AND PHOTO-ELECTRIC SENSORS

A. Refer to Division 26 Section "Lighting Control Devices" for equipment that relates to this Section.

2.12 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
   1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   2. Motor characteristics such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment." If different characteristics are required, insert additional subparagraphs below to suit Project.
   3. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
   4. Non-spring Return motors for valves larger than NPS 2-1/2: Size for running torque of 150-in. x lbf. and breakaway torque of 300-in. x lbf.
   5. Spring-Return motors for valves larger than NPS 2-1/2: Size for running and breakaway torque of 150-in. x lbf.
   6. Non-spring Return motors for dampers larger than 25 Sq. Ft.: Size for running torque of 150-in. x lbf. and breakaway torque of 300-in. x lbf.
   7. Spring-Return motors for dampers larger than 25-Sq. Ft.: Size for running and breakaway torque of 150-in. x lbf.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
   1. Manufacturers:
      a. Belimo Aircontrols (USA).
   2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
   3. Dampers: Size for running torque calculated as follows:
      a. Parallel-Blade Damper with Edge Seals: 7-inch-lb/sq. ft. of damper cross-sectional area.
      b. Opposed-Blade Damper with Edge Seals: 5-inch-lb/sq. ft. of damper cross-sectional area.
      c. Parallel-Blade Damper without Edge Seals: 4-inch-lb/sq. ft. of damper cross-sectional area.
      d. Opposed-Blade Damper without Edge Seals: 3-inch-lb/sq. ft. of damper cross-sectional area.
      e. Dampers with 2- to 3-inches wg of Pressure Drop or Face Velocities of 1000- to 2500-fpm: Increase running torque by 1.5.
      f. Dampers with 3- to 4-inches wg of Pressure Drop or Face Velocities of 2500- to 3000-fpm: Increase running torque by 2.0.
   4. Coupling: V-bolt and V-shaped, toothed cradle.
   5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
   6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual, gear release on non-spring-return actuators.
   7. Manual Operation: Provided for all valve actuators.
   8. Power Requirements (Two-Position Spring Return): 24 or 120-V ac.

9. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
10. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
11. Temperature Rating: Minus 22- to 122-degrees F.
12. Temperature Rating (Smoke Dampers): Minus 22- to 250-degrees F.
13. Run Time: 12 seconds open, 5 seconds closed.

2.13 CONTROL VALVES

A. Control Valves - General:
1. Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

B. Control Valve Piping –General:
1. Brass- and bronze-body valves shall be piped with copper/brass/bronze pipe using copper/brass/bronze piping fittings. When piping connects to ferrous piping connections, dielectrics must be used.
2. Steel- and iron-body control valves shall be piped with ferrous piping using ferrous pipe fittings. When piping connects to non-ferrous piping connections, dielectrics must be used.

C. Standard valves are also available for Class 250, 250 psig (1724 kPa) and up to 350 F (177 C) operating conditions. Coordinate with mechanical system engineer.

D. Steam Globe Control Valves shall have the following characteristics:
1. NPS 2 and Smaller: ASME/ANSI Class 250 bronze body, stainless steel trim, rising stem, renewable composition disc, screwed ends, with back-seating capacity, and repackable under pressure.
2. NPS 2-1/2 and Larger: ASME/ANSI Class 250 iron body, stainless steel trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
3. Internal Construction: Replaceable plugs and stainless steel seats.
   a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
4. Sizing: For pressure drop based on the following services:
   a. Modulating: Up to 80 percent of inlet steam pressure and meeting the coil manufacturer’s design requirements.
5. Flow Characteristics: Modified linear characteristics.
6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of operating (inlet) pressure.

2.14 DAMPERS

A. Manufacturers:
1. American Warming and Ventilating.
2. Mestek.
3. TAMCO.

4. United Enertech Corp.

B. Dampers: AMCA-rated, parallel-blade per the design requirements; 0.108-inch-minimum thickness, galvanized-steel or 0.125-inch-minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch-thick galvanized steel with maximum blade width of 8-inches and length of 48-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 200-degrees F.
   3. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals.
   4. Jamb Seals: spring-loaded, stainless steel, only.
   5. Leakage ratings or dampers shall be less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inches wg when damper is held by torque of 50 in. x lbf.; when tested according to AMCA 500D.

2.15 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that a commercial power supply is available to control units and operator workstation.

B. Verify that emergency power supply is available to control units and operator workstation if required for project.

C. Verify that the UPS is rated for the controller power needs and has been provided.

3.2 INSTALLATION

A. Install software and/or custom programming in DDC control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Install DDC controller panels in locations noted on plans or coordinate with Architect. Coordinate with Electrical Contractor for power.

D. Install DDC temperature control instruments and devices on all controlled equipment per control plans and provide supply air and control branch air piping as required for a complete installation.

E. DDC control system wiring in conduit, J-hooks, or installed in bridle rings (when allowed) shall:
   1. Run conduit runs along building and steel sight-lines (not diagonal or where support is improper).
   2. Support all conduit with independent hangers, not from ductwork/piping or from ductwork/piping hangers/trays/supports/Unistrut; and independent of other trade's work.
   3. Anchor J-hooks to walls or suspend J-hooks using 1/4-inch minimum diameter threaded rod hangers. Do not support J-hooks from ceiling or equipment hangers. J-hooks shall not impede removal of accessible ceiling tiles.

F. Control wiring and pneumatic tubing in conduit or installed exposed (when allowed) shall:
   1. Run conduit runs along building and steel sight lines (not diagonal or where support is not proper).
   2. Support all conduit with independent hangars, not from ductwork/piping or from ductwork/piping hangars/trays/supports and independent of other trade's work.
   3. Anchor J-hooks to walls or suspend J-hooks using 1/4-inch minimum diameter threaded rod hangers. Do not support J-hooks from ceiling or equipment hangers. J-hooks shall not impede removal of accessible ceiling tiles.

G. Install temperature control panels in locations noted on plans or coordinate with Architect. Coordinate with Electrical Contractor for power.

H. Install temperature control instruments and devices on all controlled equipment per control plans and provide supply air and control branch air piping as required for a complete installation.

I. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Installation height of devices
   1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

J. Install guards on thermostats in the following locations:
   1. Building Entrances
   2. Public areas and restrooms
   3. Where indicated on drawings

K. Furnish automatic dampers according to Division 23 Section "Air Duct Accessories" to installing contractor for installation.

L. Install damper motors on outside of ductwork in warm areas, not in locations exposed to outdoor temperatures.

M. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

N. Furnish steam and condensate instrument wells, valves, and other accessories according to Division 23 Section "Steam and Condensate Heating Piping" to installing contractor for installation.

O. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Route conduit and plenum cables along building and steel lines (not diagonal) and do not hang conduit or bridle rings from ductwork and piping or their support means

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

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 unit operation. Remove and replace malfunctioning units and retest.
   2. Test and adjust controls and safeties.
   3. Test each point through its full operating range to verify that safety and operating control setpoints are as required.
   4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
   5. Test each system for compliance with sequence of operation.
   6. Test software and hardware interlocks.

C. DDC Verification:
   1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
   2. Check instruments for proper location and accessibility.
   3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
   4. Check that insertion instruments are located in the correct section of piping.

5. Check instrument piping for proper fittings, slope, material, and support.
6. Check instrument tubing for proper fittings, material, and support.
7. Check installation of air supply for each instrument.
8. Check water flow instruments. Inspect tag number and line and bore size, verify that upstream/downstream dimensions are per manufacturer's requirements, and that instruments are installed correctly.
9. Check airflow instruments. Inspect tag number and ductwork size, verify that upstream/downstream dimensions are per manufacturer's requirements, and that instruments are installed correctly.
10. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
11. Check temperature instruments, material, and length of sensing elements.
12. Check control dampers/valves. Verify that proper blade alignment, either parallel or opposed, has been provided. Verify that valves are installed in the correct direction.
13. Delete subparagraph below is all electric DDC controls.
14. Check air-operated dampers/valves. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided. Verify that valves are installed in the correct direction. Verify that pilot positioners, end switches, and/or feedback devices if provided, are installed and calibrated properly.
15. Check electric-operated dampers/valves and hydraulic-operated valves. Verify that proper blade alignment, either parallel or opposed, has been provided. Verify that valves are installed in the correct direction. Verify end switches and/or feedback devices are installed properly.
16. Check DDC system as follows:
    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 ADJUSTING

A. Calibrating and Adjusting:
1. Calibrate installed devices and instruments, whether electric or pneumatic.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
    a. Check analog inputs at 0, 50, and 100 percent of span.
    b. Check analog outputs using milli-ampere meter at 0, 50, and 100 percent output.

c. Check digital inputs using jumper wire.
d. Check digital outputs using ohmmeter to test for contact making or breaking.
e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Flow:
   a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
   b. Manually operate flow switches to verify that they make or break contact.
6. Pressure:
   a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
   b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
7. Temperature:
   a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
   b. Calibrate temperature switches to make or break contacts.
8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature, CO, CO_2, static pressure, humidity, etc., set points.

C. 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 three visits to Project during other than normal occupancy hours for this purpose.

3.6 GRAPHIC DISPLAY GENERATION

A. Provide the following graphic displays as a minimum at the operator workstations, arranged in logical penetration paths:
   1. Overall campus layout which shows all of the buildings on the Owner's campus.
   2. Individual building layout or isometric for each building connected to the system.
   3. Floor plans for each floor within each building, with display of present values of space conditions sensed by connected space sensors, display of the name of the air handler associated with each space sensor, display of the room number in which the sensor is located and color coding to indicate whether the sensed space condition is within the acceptable range, is too high, or is too low. TC Contractor shall confirm Owner desired room names prior to graphics generation which may differ from the room names indicated on construction documents.

4. Schematic diagram for each HVAC system. Each system schematic display shall include at least the following:
   a. Schematic arrangement of ductwork, fans, dampers, coils, valves, piping, pumps, equipment etc.
   b. System name.
   c. Area served.
   d. Present value or status of all inputs, along with present setpoint.
   e. Present percent open for each damper, valve, etc. based on commanded position.
   f. Reset schedule parameters for all points, where applicable.
   g. Present occupancy mode.
   h. Present economizer mode, where applicable.
   i. Present outside air temperature.
   j. Associated space conditions and setpoints, where applicable.
   k. Status of application programs (e.g., warm-up, night cycle, duty cycle, etc.).
   l. Color coding to indicate normal and abnormal values, alarms, etc.
5. Manual override capability for each on/off or open/closed controlled digital output (for fans, pumps, 2-position dampers and valves, etc.) and each modulating analog output (for dampers, valves, VFD speed modulation type points, etc) shall be provided. Graphic display of output point auto or manual override status shall be provided.
6. Sequence of operation in written (text) format for each HVAC system.
7. Overall BAS system schematic.
8. System management graphic for each network device and/or DDC panel.
9. Provide a separate page for critical alarm summary.

B. Contractor to provide graphics that are fully operational prior to commissioning.

3.7 OWNER TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel on how to operate, maintain, and adjust HVAC instrumentation and controls.
   1. Training shall be provided for a period of 40 hours in 4-hour increments; to be scheduled with the Owner’s representative at least 2-weeks in advance.
   2. Provide all training materials needed for a complete training session including but not limited to Operation and Maintenance Manuals, product catalogs, and “record drawings” of the controls installation.
   3. Training shall be a combination of classroom (printed material and electronic presentations) and mechanical room (hands-on) instruction.

B. Refer to Division 01 Section "Demonstration and Training."

3.8 DATABASE CONFIGURATION

A. The Contractor will provide all labor to configure those portions of the database that are required by the points list and sequence of operation.

3.9 POINT TO POINT CHECKOUT.

A. Each I/O device (both field mounted as well as those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager for submission to the owner or owner's representative.

3.10 WORKSTATION CHECKOUT

A. A checkout of all front end equipment shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner's representative by the completion of the project.

3.11 BAS FIELD CONTROLLERS CHECKOUT

A. A checkout of all field devices shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner's representative by the completion of the project

3.12 DOCUMENTATION

A. As built software documentation will include the following:
   1. Descriptive point lists
   2. Application program listing
   3. Application programs with comments.
   4. Printouts of all reports.
   5. Alarm list.
   6. Printouts of all graphics
   7. Commissioning and System Startup
   8. An electronic copy of all databases, configuration files, or any type of files created specifically for each system.

3.13 ACCEPTANCE PROCEDURE

A. SUBMITTALS data relevant to point index, functions limits, sequences, interlocks, power fail/restarts, logs, software routines and associated parameters, and other pertinent information for the operating system and database shall be forwarded from the control system contractor to the Owner.

B. Approved database will be entered into the central computer, debugged, and down line loaded to Controllers. Prior to on-line operation, a complete demonstration and readout of the computer command shall be performed in the presence of the Owner. In addition, a printout of the database generated for all points, shall be reviewed with the Owner by the control system contractor. Modification to the database shall be made by the control system contractor as directed by the Owner.

C. All points shall be verified prior to "punch-out" for correct and accurate correspondence between the CRT data display and actual field location and equipment operation.

D. Upon successful completion of system generation the Owner shall be requested in writing to inspect and approve the satisfactory operation of the control system, sub-systems, and accessories.

3.14 DEMONSTRATION

A. Engage a factory-authorized service representative of the manufacturer (or manufacturers authorized and trained installation representative) to demonstrate the system's operational status in all modes of control. This shall be arranged for the following:

B. Modify this section to include unique arrangements and Owner's needs. This may vary significantly.
   1. Every control drawing Mxxx: Demonstrate system in all modes of operation per Sequence of Operation stated.
   2. Where there are multiple devices (VAV box, unit heater, cabinet unit heater, fan coil unit, etc.) installed identically, perform demonstration on 25% of the installed quantity, in all modes of operation per Sequence of Operation stated.

C. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 230900

SECTION 231123 - 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.

B. Division 23, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 013100 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.

1.2 SUMMARY

A. Section Includes:
1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Joining materials.
4. Valves.
5. Pressure regulators.
6. Service meters.
7. Dielectric fittings.

1.3 DEFINITIONS

A. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. An example includes rooftop locations.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. 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.

1.4 ACTION SUBMITTALS

A. Product Data:
1. Piping specialties.
2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
3. Pressure regulators. Indicate pressure ratings and capacities.
4. Service meters. 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. Shop Drawing Scale: 1/4 inch per foot.
   2. Detail mounting, supports, and valve arrangements for pressure regulator assembly.
   3. Detail mounting, supports, and valve arrangements for service meter assembly.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. 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.

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.

1.9 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 Construction Manager no fewer than seven days in advance of proposed interruption of natural-gas service.
   2. Do not proceed with interruption of natural-gas service without Construction Manager's written permission.

1.10 COORDINATION

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

B. Coordinate requirements for piping identification for natural-gas piping. Comply with requirements in Division 23 Section 230553 "Mechanical Identification."

1.11 SERVICE METERS

A. Contractor shall carry an allowance for the local utility company to furnish and install gas meter assembly as determined by the construction manager upon coordination with the local utility company.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each product type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Comply with the International Fuel Gas Code.

B. 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

C. Natural-Gas System Pressure within Buildings:
   1. Two pressure ranges. Primary pressure is more than 0.5 psig, but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

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.

2.3 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, 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 A234/A234M 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.

2.4 PIPING SPECIALTIES

A. Quick-Disconnect Devices: Comply with ANSI Z21.41.
   1. Copper-alloy convenience outlet and matching plug connector.
   2. Seals: Nitrile.
   3. Hand operated with automatic shutoff when disconnected.
   4. For indoor or outdoor applications.
   5. Adjustable, retractable restraining cable.

B. Y-Pattern Strainers:
   1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
   3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
   4. CWP Rating: 125 psig.

C. 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.

2.5 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.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.6 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
   1. CWP Rating: 125 psig.
   2. Threaded Ends: Comply with ASME B1.20.1.
   3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
   4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
   6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
   1. CWP Rating: 125 psig.
   2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
   3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

C. Two-Piece, Full-Port, Brass or Bronze Ball Valves with Brass or Bronze Trim: MSS SP-110.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. A. Y. McDonald Mfg. Co.
      b. BrassCraft Manufacturing Company.
      c. Conbraco Industries.
      d. Milwaukee Valve Company.
      e. Hammond Valve, Milwaukee Valve Company.
   2. Body: Forged brass or bronze, complying with ASTM B584.
   3. Ball: Chrome-plated brass or bronze.
   4. Stem: Brass or Bronze; blowout proof.
   5. Seats: Reinforced TFE; blowout proof.
   6. Packing: Threaded-body packnut design with adjustable-stem packing.
   7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   8. CWP Rating: 600 psig.
   9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. A. Y. McDonald Mfg. Co.
      b. American Production Valve
      c. Mueller Co.
      d. Xomox Corporation.
   2. Body: Cast iron, complying with ASTM A126, Class B.
   3. Plug: Bronze or nickel-plated cast iron.
   4. Seat: Coated with thermoplastic.
   5. Stem Seal: Compatible with natural gas.
   6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   7. Operator: Square head or lug type with tamperproof feature where indicated.
   8. Pressure Class: 125 psig.
   9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. A. Y. McDonald Mfg. Co.
      b. Flowserve Corporation.
      c. Homestead Valve.
      d. Milliken Valve Company.
      e. Mueller Co.
      f. R&M Energy Systems.
   2. Body: Cast iron, complying with ASTM A126, Class B.
   3. Plug: Bronze or nickel-plated cast iron.
   4. Seat: Coated with thermoplastic.
   5. Stem Seal: Compatible with natural gas.
   6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   7. Operator: Square head or lug type with tamperproof feature where indicated.
   8. Pressure Class: 125 psig.
   9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.7 PRESSURE REGULATORS

A. General Requirements:
   1. Single stage and suitable for natural gas.
   2. Steel jacket and corrosion-resistant components.
   3. Elevation compensator.

4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Actaris.
      b. American Meter Company.
      c. Eclipse Inovated Thermal Technologies.
      d. Fisher Control Valves and Instruments.
      e. Invensys.
      f. Itron Gas.
      g. Maxitrol Company.
      h. Richards Industries.
   2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
   3. Springs: Zinc-plated steel; interchangeable.
   4. Diaphragm Plate: Zinc-plated steel.
   5. Seat Disc: NBR resistant to gas impurities, abrasion, and deformation at the valve port.
   6. Orifice: Aluminum; interchangeable.
   7. Seal Plug: UV-stabilized, mineral-filled nylon.
   8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
   9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
   10. Overpressure Protection Device: Factory mounted on pressure regulator.
   11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
   12. Maximum Inlet Pressure: 2 psig

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Canadian Meter Company.
      b. Eaton Corporation.
      c. Harper Wyman Co.
      d. Maxitrol Company.
      e. SCP.
   2. Body and Diaphragm Case: Die-cast aluminum.
   3. Springs: Zinc-plated steel; interchangeable.
   4. Diaphragm Plate: Zinc-plated steel.
   5. Seat Disc: NBR.
   6. Seal Plug: UV-stabilized, mineral-filled nylon.
   7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
   8. Regulator shall include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
   9. Maximum Inlet Pressure: 2 psig

2.8 SERVICE METERS

A. Contractor to coordinate installation of Natural Gas equipment with local utility company and provide terminations as required facilitating the meter assembly installation by the local utility company.

2.9 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. A. Y. McDonald Mfg. Co.
      b. Capitol Manufacturing Company.
      c. Central Plastics Company.
      d. Hart Industrial Union.
      e. Jomar Valve.
      f. Matco-Norca.
      g. Watts.
      h. Wilkins.
      i. Zurn Industries.
   2. Description:
      a. Standard: ASSE 1079.
      b. Minimum Operating-Pressure Rating: 150 psig.
      c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Capitol Manufacturing Company.
      b. Central Plastics Company.
      c. Metco-Norca.
      d. Watts.
      e. Wilkins.
   2. Description:
      a. Standard: ASSE 1079.
      b. Factory-fabricated, bolted, companion-flange assembly.
      c. Minimum Operating-Pressure Rating: 150 psig
      d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Advance Products & Systems.
      b. Calpico.

c. Central Plastics Company.
d. Pipeline Seal and Insulator.

2. Description:
   a. Nonconducting materials for field assembly of companion flanges.
   b. Pressure Rating: 150 psig.
   c. Gasket: Neoprene or phenolic.
   d. Bolt Sleeves: Phenolic or polyethylene.
   e. Washers: Phenolic with steel backing washers.

2.10 SLEEVES

A. Refer to Division 23 Section 230500 “Common Work Results” for requirements.

2.11 MECHANICAL SLEEVE SEALS

A. Refer to Division 23 Section 230500 “Common Work Results” for requirements.

2.12 ESCUTCHEONS

A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.

B. Refer to Division 23 Section 230500 “Common Work Results” for requirements.

2.13 GROUT

A. Refer to Division 23 Section 230500 “Common Work Results” for requirements.

2.14 LABELING AND IDENTIFYING

A. Refer to Division 23 Section 230500 “Mechanical Identification” for requirements.

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 International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with NFPA 54 and the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.

B. 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.

C. Install fittings for changes in direction and branch connections.

D. Install pressure gage upstream and downstream from each service regulator.

3.4 INDOOR PIPING INSTALLATION

A. Comply with NFPA 54 and the International Fuel Gas Code 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. Do not install piping in concealed locations unless sleeved with the sleeve open at both ends.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access. Do not locate valves within return air plenums.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
   1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
   2. Install sediment trap on both sides of regulators for gas reduction to 2 psig with valve and capped.

N. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
   1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
   2. Prohibited Locations:
      a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
      b. Do not install natural-gas piping in solid walls or partitions.

O. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

P. Connect branch piping from top or side of horizontal piping.

Q. 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.

R. Do not use natural-gas piping as grounding electrode.

S. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

T. Install pressure gage upstream and downstream from each line regulator.

3.5 INSTALLATION OF SERVICE-METER ASSEMBLIES

A. Service meter assembly will be purchased by the contractor and furnished and installed by the fuel gas company.

3.6 INSTALLATION OF VALVES

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

3.7 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.

3.8 INSTALLATION OF HANGER AND SUPPORTS

A. Comply with requirements for pipe hangers and supports specified in Division 20 Section 230529 "Hangers and Supports."

B. Install hangers for steel piping with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Support horizontal piping within 12 inches of each fitting.

D. Support vertical runs of steel piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support vertical runs of corrugated stainless-steel tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.9 PIPING 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.

3.10 LABELING AND IDENTIFICATION

A. Comply with requirements in Division 23 Section 230553 "Mechanical Identification" for piping and valve identification.

3.11 PAINTING

A. Comply with requirements in Division 9 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.
      d. Color: Yellow

C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.12 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Test, inspect, and purge natural gas according to NFPA 54 and the International Fuel Gas Code and authorities having jurisdiction.

2. Natural-gas piping will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports.

3.13 OUTDOOR PIPING SCHEDULE

A. Aboveground natural-gas piping shall be one of the following:
1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

3.14 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:
1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

3.15 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:
1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with steel welding fittings and welded joints.

3.16 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.

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. Cast-iron, lubricated plug valve.

C. Distribution piping valves shall be:
1. Two-piece, full-port, bronze ball valves with bronze trim.

D. Valves in branch piping for single appliance shall be one of the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION 231123

SECTION 232213 - STEAM AND CONDENSATE HEATING 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.

B. Division 23, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 013100 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.

1.2 SUMMARY

A. Section includes pipe and fittings for LP steam and condensate piping:

B. Related Requirements:
1. Division 23 Section 232216 "Steam and Condensate Piping Specialties" for strainers, flash tanks, special-duty valves, steam traps, thermostatic air vents and vacuum breakers, and steam and condensate meters.

1.3 ACTION SUBMITTALS

A. Product Data: For RTRP and RTRF and adhesive.

B. Delegated-Design Submittal:
1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Suspended ceiling components.
2. Other building services.
3. Structural members.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

B. Pipe Welding: Qualify procedures and operators according to the following:
   1. ASME Compliance: Comply with [ASME B31.9, "Building Services Piping," for materials, products, and installation.
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Steam/Condensate Service: Do not interrupt steam/condensate service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary steam/condensate service according to requirements indicated:
   1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of steam/condensate service.
   2. Do not interrupt steam/condensate service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:
   1. LP Steam Piping: <Less than 15#.
   2. Condensate Piping: Less than 15# at 250 deg F.
   3. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, plain ends, welded and seamless, Grade B, and Schedule as indicated in piping applications articles.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in piping applications articles.

C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in piping applications articles.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in piping applications articles.

E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in piping applications articles; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   1. Material Group: 1.1.
   2. End Connections: Butt welding.
   3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

D. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

PART 3 - EXECUTION

3.1 LP STEAM PIPING APPLICATIONS

A. LP Steam Piping, NPS 2 and Smaller: Schedule 40, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. LP Steam Piping, NPS 2-1/2 through NPS 4: Schedule 40, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. Condensate piping, NPS 2 and smaller, shall be the following:
   1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

D. Condensate piping, NPS 2-1/2 and larger, shall be the following:
   1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

3.2 ANCILLARY PIPING APPLICATIONS

A. Vacuum-Breaker Piping: Outlet, same as service where installed.

3.3 VALVE APPLICATIONS

A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

3.4 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

K. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.

M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to top of main pipe.

P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

R. Identify piping as specified in Division 20 Section 200553 "Mechanical Identification."

S. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.

3.5 STEAM AND CONDENSATE PIPING SPECIALTIES INSTALLATION

A. Comply with requirements in Division 23 Section 232216 "Steam and Condensate Piping Specialties" for installation requirements for strainers, flash tanks, special-duty valves, steam traps, thermostatic air vents and vacuum breakers, and steam and condensate meters.

3.6 HANGERS AND SUPPORTS

A. Comply with requirements in Division 23 Section 230529 "Hangers and Supports" for installation of hangers and supports. Comply with requirements below for maximum spacing.

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
   2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.

C. Install hangers for steel steam supply piping with the following maximum spacing:
   1. NPS 3/4: Maximum span, 9 feet.
   2. NPS 1: Maximum span, 9 feet.
   3. NPS 1-1/2: Maximum span, 12 feet.
   4. NPS 2: Maximum span, 13 feet.
   5. NPS 2-1/2: Maximum span, 14 feet.
   6. NPS 3 and Larger: Maximum span, 15 feet.

D. Install hangers for steel steam condensate piping with the following maximum spacing:
   1. NPS 3/4: Maximum span, 7 feet.
   2. NPS 1: Maximum span, 7 feet.
   3. NPS 1-1/2: Maximum span, 9 feet.
   4. NPS 2: Maximum span, 10 feet.
   5. NPS 2-1/2: Maximum span, 11 feet.
   6. NPS 3 and Larger: Maximum span, 12 feet

3.7 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.8 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping according to ASME B31.9, "Building Services Piping," and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.

2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush 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.

B. Perform the following tests and inspections:
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. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
3. 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.

C. Prepare test and inspection reports.

END OF SECTION 232213

SECTION 232216 - STEAM AND CONDENSATE PIPING SPECIALTIES

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. Division 23, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 013100 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.

1.2 SUMMARY

A. Section includes the following piping specialties for **LP** steam and condensate piping:
   1. Strainers.
   2. Safety valves.
   3. Steam traps.
   4. Thermostatic air vents and vacuum breakers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Steam trap.
   2. Air vent and vacuum breaker.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For valves, steam traps, air vents, and vacuum breakers, to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:
   1. LP Steam Piping: Less than 15#.
   2. Condensate Piping: Less than 15# at 250 deg F.
   3. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.

2.2 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section 230523 "General Duty Valves for Piping."

B. Stop-Check Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. A.Y. McDonald Mfg. Co.
      b. Cincinnati Valve Company.
      c. Crane.
      d. Jenkins Valves.
      e. Lunkenheimer Valves.
   2. Body and Bonnet: Malleable iron.
   3. End Connections: Flanged.
   4. Disc: Cylindrical with removable liner and machined seat.
   5. Stem: Brass alloy.
   6. Operator: Outside screw and yoke with cast-iron handwheel.
   7. Packing: Polytetrafluoroethylene-impregnated packing with two-piece packing gland assembly.
   8. Pressure Class: 250.

2.3 STRAINERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong International.
   2. Anvil International.
   3. Keckley Co.
   4. Metraflex Co.
   5. Mueller Steam Specialty Co.
   6. Spirax-Sarco.
   7. Watts.
   8. Yarway.

B. Y-Pattern Strainers:
   1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
   3. Strainer Screen: Stainless-steel, 40-mesh strainer, or perforated stainless-steel basket.
   4. Tapped blowoff plug.
   5. CWP Rating: 250-psig working steam pressure.

C. Basket Strainers:
   1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, **20** mesh strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 250-psig working steam pressure.

2.4 STEAM TRAPS

A. Thermostatic Traps:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International.
   b. Barnes & Jones.
   c. Hoffman Specialty.
   d. Sterling.
   e. Spirax Sarco.
   f. Watson McDaniels.
2. Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.
3. Trap Type: Balanced-pressure.
4. Bellows: Stainless steel or monel.
5. Head and Seat: Replaceable, hardened stainless steel.
6. Pressure Class: 125.

B. Float and Thermostatic Traps:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International.
   b. Barnes & Jones.
   c. Hoffman Specialty.
   d. Sterling.
   e. Spirax Sarco.
   f. Watson McDaniels.
2. Body and Bolted Cap: ASTM A 126, cast iron.
3. End Connections: Threaded.
4. Float Mechanism: Replaceable, stainless steel.
5. Head and Seat: Hardened stainless steel.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.
8. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
9. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless-steel cage, valve, and seat.
10. Maximum Operating Pressure: 125 psig.

C. Inverted Bucket Traps:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International.
   b. Barnes & Jones.

c. Hoffman Specialty.
d. Sterling.
e. Spirax Sarco.
f. Watson McDaniels.

2. Body and Cap: Cast iron.
3. End Connections: Threaded.
4. Head and Seat: Stainless steel.
5. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
6. Bucket: Brass or stainless steel.
7. Strainer: Integral stainless-steel inlet strainer within the trap body.
8. Air Vent: Stainless-steel thermostatic vent.
9. Pressure Rating: 250 psig.

2.5 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Air Vents:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Armstrong International.
b. Barnes & Jones.
c. Hoffman Specialty.
d. Sterling.
e. Spirax Sarco.
f. Watson McDaniels.
2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Float, Valve, and Seat: Stainless steel.
5. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
6. Pressure Rating: 125 psig
7. Maximum Temperature Rating: 350 deg F

B. Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Armstrong International.
b. Hoffman Specialty.
c. Johnson Corporation.
d. Spirax Sarco.
2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
5. O-Ring Seal: EPR.
6. Pressure Rating: 125 psig
7. Maximum Temperature Rating: 350 deg F

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

3.2 PIPING INSTALLATION

A. Install piping to permit valve servicing.

B. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

C. Install valves according to Division 23 Section 230523 "General-Duty Valves for Piping."

D. Install unions in piping, NPS 2and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

E. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

F. Install shutoff valve immediately upstream of each dielectric fitting.

G. Install strainers on supply side of control valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

3.3 STEAM-TRAP INSTALLATION

A. Install steam traps in accessible locations as close as possible to connected equipment.

B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated. Provide a dirt pocket not less than 4 inches long and fitted with threaded cap on the bottom.

C. Install at all low points in steam lines, the bottom of down feed risers, and the return end of all equipment where steam is condensed, shall have traps of proper size and type.

D. Traps for draining heating and ventilating equipment, heating coils, forced flow units, water heaters, and convertors, and all equipment with 15# or less modulating steam service shall be inverted bucket traps.

E. Steam trap of a temperature-regulated equipment must not be located at less than 14 inches below the bottom of the coil outlet, and condensate discharge from the trap must flow by gravity, without any lifts in the piping, to the condensate receiver.

F. Lifting of condensate for modulating steam service shall not be acceptable.

3.4 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install vacuum breakers downstream from control valve, close to coil inlet connection.

D. Install a drip leg at coil outlet.

END OF SECTION 232216

SECTION 232300 - REFRIGERANT 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.

B. Division 23, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 013100 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.

1.2 SUMMARY

A. Section Includes:
   1. Refrigerant pipes and fittings.
   2. Refrigerant piping valves and specialties.
   3. Refrigerants.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty.
   1. Include pressure drop, based on manufacturer's test data, for the following:
      a. Thermostatic expansion valves.
      b. Solenoid valves.
      c. Hot-gas bypass valves.
      d. Filter dryers.
      e. Strainers.
      f. Pressure-regulating valves.

B. Shop Drawings:
   1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.
   2. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
   3. Shop Drawing Scale: 1/4 inch equals 1 foot

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:
   1. Suction Lines for Air-Conditioning Applications: 300 psig.
   2. Hot-Gas and Liquid Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Brazing Filler Metals: AWS A5.8.

E. Flexible Connectors:
   1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
   2. End Connections: Socket ends.
   3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
   4. Pressure Rating: Factory test at minimum 500 psig.
   5. Maximum Operating Temperature: 250 deg F.

2.3 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Danfoss.
      b. Heldon Products.
      c. Parker Hannifin Corp.
      d. Paul Mueller Company.
   2. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
   3. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
   4. Operator: Rising stem and hand wheel.
   5. Seat: Nylon.
   6. End Connections: Socket, union, or flanged.
   7. Working Pressure Rating: 500 psig.
   8. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Danfoss.
      b. Heldon Products.
      c. Parker Hannifin Corp.
      d. Paul Mueller Company.
   2. Body and Bonnet: Forged brass or cast bronze.
   3. Packing: Molded stem, back seating, and replaceable under pressure.
   4. Operator: Rising stem.
   5. Seat: Nonrotating, self-aligning Polytetrafluoroethylene.
   6. Seal Cap: Forged-brass or valox hex cap.
   7. End Connections: Socket, union, threaded, or flanged.
   8. Working Pressure Rating: 500 psig.
   9. Maximum Operating Temperature: 275 deg F.

C. Check Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Danfoss.
      b. Emerson Climate Technologies.
      c. Heldon Products.
      d. Parker Hannifin Corp.
      e. Paul Mueller Company.
   2. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
   3. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
   4. Piston: Removable Polytetrafluoroethylene seat.
   5. Closing Spring: Stainless steel.
   6. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
   7. End Connections: Socket, union, threaded, or flanged.
   8. Maximum Opening Pressure: 0.50 psig.

9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 275 deg F.

D. Service Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss.
   b. Emerson Climate Technologies.
   c. Heldon Products.
   d. Parker Hannifin Corp.
   e. Paul Mueller Company.
   f. Refrigeration Sales.
2. Body: Forged brass with brass cap including key end to remove core.
3. Core: Removable ball-type check valve with stainless-steel spring.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Copper spring.
6. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss.
   b. Emerson Climate Technologies.
   c. Heldon Products.
   d. Parker Hannifin Corp.
   e. Paul Mueller Company.
2. Body and Bonnet: Plated steel.
3. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Threaded.
6. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24V ac coil.
7. Working Pressure Rating: 400 psig.
8. Maximum Operating Temperature: 240 deg F.
9. Manual operator.

F. Thermostatic Expansion Valves: Comply with ARI 750.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss.
   b. Emerson Climate Technologies.
   c. Heldon Products.
   d. Paul Mueller Company.
2. Body, Bonnet, and Seal Cap: Forged brass or steel.
3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
4. Packing and Gaskets: Non-asbestos.
5. Capillary and Bulb: Copper tubing filled with refrigerant charge.
6. Suction Temperature: 40 deg F
7. End Connections: Socket, flare, or threaded union.

8. Working Pressure Rating: 450 psig.

G. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss.
   b. Heldon Products.
   c. Parker Hannifin Corp.
2. Body, Bonnet, and Seal Cap: Ductile iron or steel.
3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
4. Packing and Gaskets: Non-asbestos.
5. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
6. Seat: Polytetrafluoroethylene.
7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
8. End Connections: Socket.
9. Throttling Range: Maximum 5 psig.
10. Working Pressure Rating: 500 psig.
11. Maximum Operating Temperature: 240 deg F.

H. Straight-Type Strainers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss.
   b. Heldon Products.
   c. Parker Hannifin Corp.
2. Body: Welded steel with corrosion-resistant coating.
3. Screen: 100-mesh stainless steel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

I. Angle-Type Strainers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss.
   b. Heldon Products.
   c. Parker Hannifin Corp.
2. Body: Forged brass or cast bronze.
3. Drain Plug: Brass hex plug.
4. Screen: 100-mesh Monel.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

J. Moisture/Liquid Indicators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Danfoss.

b. Emerson Climate Technologies.
c. Heldon Products.
d. Parker Hannifin Corp.
2. Body: Forged brass.
3. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
4. Indicator: Color coded to show moisture content in ppm.
5. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
6. End Connections: Socket or flare.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 240 deg F.

K. Permanent Filter Dryers: Comply with ARI 730.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Danfoss.
b. Emerson Climate Technologies.
c. Heldon Products.
d. Parker Hannifin Corp.
2. Body and Cover: Painted-steel shell.
3. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
4. Desiccant Media: Activated alumina
5. Designed for reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
8. Maximum Pressure Loss: 2 psig
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

L. Mufflers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Danfoss.
b. Emerson Climate Technologies.
c. Heldon Products.
2. Body: Welded steel with corrosion-resistant coating.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

M. Liquid Accumulators: Comply with ARI 495.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Emerson Climate Technologies.
b. Heldon Products.
c. Parker Hannifin Corp.
2. Body: Welded steel with corrosion-resistant coating.
3. End Connections: Socket or threaded.

4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

2.4 REFRIGERANTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Arkema.
   2. DuPont Fluorochemicals Div.
   3. Genetron Refrigerants.
   4. Mexichem Flour.

B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines: Copper, Type ACR annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install packed-angle valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install packed-angle valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
   1. Install valve so diaphragm case is warmer than bulb.
   2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
   3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

I. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
   1. Solenoid valves.
   2. Thermostatic expansion valves.
   3. Hot-gas bypass valves.
   4. Compressor.

J. Install filter dryers in liquid line between compressor and thermostatic expansion valve.

K. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Division 23 Section 230900 Sections "Instrumentation and Control for HVAC" and Drawings for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection.

M. Install refrigerant piping in protective conduit where installed below ground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:
1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

P. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

R. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

S. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section 230529 "Hangers and Supports for Piping and Equipment."

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
   2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Comply with ASME B31.5, Chapter VI.
   2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
   3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
      a. Fill system with nitrogen to the required test pressure.
      b. System shall maintain test pressure at the manifold gage throughout duration of test.
      c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
      d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:
   1. Install core in filter dryers after leak test but before evacuation.
   2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
   3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
   4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
   1. Open shutoff valves in condenser water circuit.
   2. Verify that compressor oil level is correct.
   3. Open compressor suction and discharge valves.
   4. Open refrigerant valves except bypass valves that are used for other purposes.
   5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

D. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 233113 - METAL DUCTS

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. Division 23 Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 013100 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.

D. Division 20 Section 235993 "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing requirements for metal ducts.

E. Division 23 Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 SUMMARY

A. Section Includes:
1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.

1.3 DEFINITIONS

A. ASCE/SEI: American Society of Civil Engineers/Structural Engineers Institute.

B. ASHRAE: American Society of Heating, Refrigeration, and Air Conditioning Engineers.

C. AWS: American Welding Society.

D. CFR: Code of Federal Regulations.

E. EPA: Environmental Protection Agency.

F. EPDM: Ethylene-propylene-diene terpolymer rubber.

G. ICC: International Code Council.

H. IESNA: Illuminating Engineers Society of North America.

I. NFPA: National Fire Protection Association.

J. NRTL: Nationally Recognized Testing Laboratory.

K. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

L. SPIDA: Spiral Duct Manufacturers Association.

M. UL: Underwriters Laboratories, Inc.

N. VOC: Volatile Organic Compound.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

E. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following products:
   1. Liners and adhesives.
   2. Sealants and gaskets.

B. Shop Drawings: CAD-generated and drawn to 1/4 inch equals 1 foot scale. Show fabrication and installation details for metal ducts. Shop drawings are to be reviewed by the Architect prior to any fabrication.
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Factory- and shop-fabricated ducts and fittings.
   3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
   4. Elevation of top and bottom of ducts.
   5. Dimensions of main duct runs from building grid lines.
   6. Fittings.
   7. Reinforcement and spacing.

8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

D. 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 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
1. Galvanized Coating Designation: G90
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

D. 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.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
   1. Minimum steel gauge shall be as follows unless pressure class requires thicker gage:
      a. Ducts through 12 Inches wide: 24 gauge.
      b. Ducts 13 through 30 inches wide: 22 gauge.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eastern Sheet Metal (ESM).
   2. Lindab.
   3. McGill AirFlow.
   4. SEMCO.
   5. Sheet Metal Connectors.
   6. Spiral Manufacturing Co.

C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Transverse joints in ducts 60 inches and smaller in diameter shall be flanged, beaded sleeve, or draw band joint.

E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Fabricate round ducts 90 inches and smaller in diameter with one of the following based on indicated pressure class:
      a. Equal to or greater than +/- 4 inches.
         1) Butt Weld Seam.
         2) Spiral Seam.
      b. Equal to or less than +/- 4 inches.
         1) Spiral Seam.
         2) Lap and Rivet.
         3) Grooved Seam
      c. Exposed ductwork shall be spiral seam unless otherwise noted.

F. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:
   1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
   2. Tape Width: **3 inches**
   3. Sealant: Modified styrene acrylic.
   4. Water resistant.
   5. Mold and mildew resistant.
   6. Maximum Static-Pressure Class: 10-inch w.g., positive and negative.
   7. Service: Indoor and outdoor.
   8. Service Temperature: Minus 40 to plus 200 deg F.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

1. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch w.g., positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
1. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch w.g. and shall be rated for 10-inch w.g. static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
1. Refer to project details for allowable fittings.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through required exit stairwells, elevator hoistways and machinery rooms, transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section 233300 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
   1. See Duct System Application Schedule on plans.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
   5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:
   1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
   2. Test the following systems:
      a. Supply Ducts with a Pressure Class of 2-Inch w.g.or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
      b. Exhaust Ducts with a Pressure Class of 2-Inch w.g.or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
   3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
   4. Test for leaks before applying external insulation.
   5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
   6. Give **seven** days' advance notice for testing.

C. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.

2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
   a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. New ducts that are protected from debris during onsite storage and after installation, and meet the requirements of the Duct System Cleanliness Test do not require additional cleaning.

C. 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 233300 "Air Duct Accessories" for access panels and doors.
   2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
   3. Remove and reinstall ceiling to gain access during the cleaning process.

D. 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.

E. 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.

F. 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.

3.8 START UP

A. Air Balance: Comply with requirements in Division 23 Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

A. See Duct System Application Schedule on Plans

B. Intermediate Reinforcement:
   1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.

C. Elbow Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
      a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
      c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
   2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
      a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
         1) Radius-to Diameter Ratio: 1.5.
      b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.

c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

D. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

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. Division 23, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 013100 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.

1.2 SUMMARY

A. Section Includes:
1. Backdraft and pressure relief dampers.
2. Barometric relief dampers.
3. Manual volume dampers.
4. Control dampers.
5. Turning vanes.
6. Duct-mounted access doors.
7. Flexible connectors.

1.3 ACTION SUBMITTALS

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

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
a. Manual volume damper installations.
b. Control damper installations.
c. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. Comply with AMCA 500-D testing for damper rating.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G90.
   2. Exposed-Surface Finish: Mill phosphatized.

B. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

D. 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 AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Warming and Ventilating.
   2. Greenheck Fan Corporation.
   3. Nailor Industries.
   4. Ruskin Company.
   5. SEMCO.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm

D. Maximum System Pressure: 2-inch wg

E. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel with welded corners or mechanically attached and mounting flange.

F. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch width, 0.050-inch-thick aluminum sheet with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Neoprene, mechanically locked.

I. Blade Axles:
   1. Material: Galvanized steel
   2. Diameter: 0.20 inch

J. Tie Bars and Brackets: Galvanized steel.

K. Return Spring: Adjustable tension.

L. Bearings: Steel ball or synthetic pivot bushings.

M. Accessories:
   1. Adjustment device to permit setting for varying differential static pressure.
   2. Counterweights and spring-assist kits for vertical airflow installations.

2.4 BAROMETRIC RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Warming and Ventilating.
   2. Greenheck Fan Corporation.
   3. Nailor Industries.
   4. Ruskin Company.
   5. SEMCO.

B. Suitable for horizontal or vertical mounting.

C. Maximum Air Velocity: 1000 fpm.

D. Maximum System Pressure: 2-inch wg.

E. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel with welded corners or mechanically attached and mounting flange.

F. Blades:
   1. Multiple, 0.025-inch-thick, roll-formed aluminum.
   2. Maximum Width: 6 inches.
   3. Action: Parallel.
   4. Balance: Gravity.

G. Blade Seals: Neoprene.

H. Blade Axles: Galvanized steel.

I. Tie Bars and Brackets:
   1. Material: Galvanized steel.
   2. Rattle free with 90-degree stop.

J. Return Spring: Adjustable tension.

K. Bearings: Synthetic

L. Accessories:
   1. Flange on intake.
   2. Adjustment device to permit setting for varying differential static pressures.

2.5 MANUAL VOLUME DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Warming and Ventilating.
   2. Flexmaster U.S.A.
   3. Greenheck Fan Corporation.
   4. METALAIRE.
   5. Nailor Industries.
   6. Ruskin Company.

B. Low-Leakage, Steel, Manual Volume Dampers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Warming and Ventilating.
      b. Flexmaster U.S.A.
      c. Greenheck Fan Corporation.
      d. METALAIRE.
      e. Nailor Industries.
      f. Ruskin Company.
   2. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
   3. Suitable for horizontal or vertical applications.
   4. Frames:
      a. Hat shaped.
      b. 0.094-inch-thick, galvanized sheet steel
      c. Mitered and welded corners.
      d. Flanges for attaching to walls and flangeless frames for installing in ducts.
   5. Blades:
      a. Multiple or single blade.
      b. Parallel- or opposed-blade design.
      c. Stiffen damper blades for stability.
      d. Galvanized, roll-formed steel, 0.064 inch thick.

6. Blade Axles: Galvanized steel.
7. Bearings:
   a. Oil-impregnated bronze
   b. Dampers in ducts with pressure classes of 3-inch w.g. or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Blade Seals: Neoprene.
9. Jamb Seals: Cambered aluminum.
10. Tie Bars and Brackets: Galvanized steel
11. Accessories:
    a. Include locking device with 2” stand-off bracket to hold single-blade dampers in a fixed position without vibration.

C. Jackshaft:
1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware:
1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.6 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Warming and Ventilating.
2. Greenheck Fan Corporation.
3. METALAIRE.
4. Nailor Industries.
5. Ruskin Company.

B. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:
1. Hat shaped.
2. 0.094-inch-thick, galvanized sheet steel
3. Mitered and welded corners.

D. Blades:
1. Multiple blade with maximum blade width of 6 inches.
2. Parallel-blade design.
3. Galvanized-steel.
4. 0.064-inch-thick single skin.

5. Blade Edging: Closed-cell neoprene.
6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

E. Blade Axles: 1/2-inch-diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From minus 40 to plus 200 deg F.

F. Bearings:
1. Oil-impregnated bronze.
2. Dampers in ducts with pressure classes of 3-inch w.g. or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.7 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries.
2. METALAIRE.
3. SEMCO.
4. Ward Industries.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

E. Vane Construction: Single wall.

2.8 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Warming and Ventilating.
2. Ductmate Industries.
3. Flexmaster U.S.A.
4. Greenheck Fan Corporation.
5. Nailor Industries.
6. Ruskin.
7. Ward Industries.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
   1. Door:
      a. Double wall, rectangular.
      b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
      c. Vision panel.
      d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
      e. Fabricate doors airtight and suitable for duct pressure class.
   2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
   3. Number of Hinges and Locks:
      a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
      b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.

2.9 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries.
   2. Duro Dyne.
   3. Ventfabrics.
   4. Ward Industries.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip **3-1/2 inches** wide attached to 2 strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

E. 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.

F. 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.

G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
   1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
   2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
   7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.10 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of Pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft or control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   2. At each change in direction and at maximum 50-foot spacing.
   3. Upstream from turning vanes.
   4. Control devices requiring inspection.
   5. Elsewhere as indicated.

G. Install access doors with swing against duct static pressure.

H. Install flexible connectors to connect ducts to equipment.

I. Install duct test holes where required for testing and balancing purposes.

J. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.
   3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
   4. Inspect turning vanes for proper and secure installation.
   5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 233423 - HVAC POWER VENTILATORS

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. Division 23, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 013100 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.

1.2 SUMMARY

A. This Section includes the following:
   1. Centrifugal roof ventilators.
   2. Upblast propeller roof exhaust fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level.

B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   3. Material thickness and finishes, including color charts.
   4. Dampers, including housings, linkages, and operators.
   5. Roof curbs.
   6. Fan speed controllers.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Belts: One set(s) for each belt-driven unit.

1.8 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. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.9 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Engineering & Mfg. Corp.
   2. Aerovent.
   3. Greenheck Fan Corporation.
   4. Loren Cook Company.
   5. PennBarry.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle, square, one-piece, aluminum base with venturi inlet cone.
   1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector.
   2. Hinged Sub-base: Galvanized-steel hinged arrangement permitting service and maintenance.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt Drives:
   1. Resiliently mounted to housing.
   2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
   4. Pulleys: Cast-iron, adjustable-pitch motor pulley.
   5. Fan and motor isolated from exhaust airstream.

E. Accessories:
   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
   3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
   4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
   5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
   1. Configuration: Built-in cant and mounting flange
   2. Overall Height: 18 inches.
   3. Metal Liner: Galvanized steel.
   4. Mounting Pedestal: Galvanized steel with removable access panel.
   5. Vented Curb: Unlined with louvered vents in vertical sides.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 20 Section 200513 "Common Motor Requirements for Mechanical 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.

B. Enclosure Type: Totally enclosed, fan cooled.

2.3 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Division 07 Section 077200 "Roof Accessories" for installation of roof curbs.

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Division 23 Section 230553 "Mechanical Identification."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.

4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
9. Shut unit down and reconnect automatic temperature-control operators.
10. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Division 23 Section 230593 "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION 233423

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

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. Division 23, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 013100 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.

D. Division 23 Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.2 SUMMARY

A. Section Includes:
   1. Square ceiling diffusers.
   2. Louver face diffusers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of 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.

1.4 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

PART 2 - PRODUCTS

2.1 DIFFUSERS

A. Louver Face Diffuser:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. METALAIRE.
      b. Nailor Industries.
      c. Price Industries.

d. Titus.
e. Tuttle & Bailey.

4. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Steel.
4. Finish: Baked enamel, white.
5. Mounting: Side-wall duct mounted.
6. Pattern: Two-way core style.
7. Dampers: Radial opposed blade.
8. Accessories:
   a. Square to round neck adaptor.
   b. Adjustable pattern vanes.

2.2 REGISTERS AND GRILLES

A. Fixed Face Grille:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anemostat Products.
   b. Carnes Company.
   c. Hart & Cooley.
   d. Krueger.
   e. Nailor Industries.
   f. Price Industries.
   g. Titus.
   h. Tuttle & Bailey.
6. Material: Steel
3. Finish: Baked enamel, white.
4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
5. Core Construction: Integral.
6. Frame: 1 inch.
7. Mounting: Lay in.

2.3 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 diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

D. Support flexible duct connectors at connection to air diffusion devices with "FLEXFLOW ELBOW" elastomeric duct elbow support as manufacturered by Thermaflex or approved equal.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 233723 - HVAC GRAVITY VENTILATORS

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. Division 23, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 013100 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.

1.2 SUMMARY

A. Section Includes:
   1. Roof hoods.

1.3 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.

B. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: For gravity ventilators. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
   1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof framing 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. Structural members to which roof curbs and ventilators will be attached.
   2. Sizes and locations of roof openings.

B. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
   2. AWS D1.3, "Structural Welding Code - Sheet Steel."

1.7 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.

B. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 zinc coating, mill phosphatized.

C. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.
   1. Use types and sizes to suit unit installation conditions.
   2. Use screws for exposed fasteners unless otherwise indicated.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 FABRICATION, GENERAL

A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.

D. Fabricate supports, anchorages, and accessories required for complete assembly.

E. Perform shop welding by AWS-certified procedures and personnel.

2.3 ROOF HOODS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Acme Engineering & Mfg. Corporation.
   2. Aerovent.
   3. Greenheck Fan Corporation.
   4. Loren Cook Company.
   5. PennBarry.

B. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 6-6 and 6-7.

C. Materials: Galvanized-steel sheet, minimum 0.064-inch-thick base and 0.040-inch-thick hood; suitably reinforced.

D. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch-thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.
   1. Configuration: Built-in cant and mounting flange.
   2. Overall Height: 18 inches.

E. Bird Screening: Aluminum, 1/2-inch-square mesh, 0.063-inch wire

F. Galvanized-Steel Sheet Finish:
   1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.
   2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
   3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.
      a. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.

B. Install gravity ventilators with clearances for service and maintenance.

C. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

D. Label gravity ventilators according to requirements specified in Division 23 Section 230553 "Mechanical Identification."

E. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

F. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in Division 23 Section 233113 "Metal Ducts". Drawings indicate general arrangement of ducts and duct accessories.

3.3 ADJUSTING

A. Adjust damper linkages for proper damper operation.

END OF SECTION 233723

SECTION 233813 - COMMERCIAL-KITCHEN HOODS

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. Division 23, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 013100 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.

1.2 SUMMARY

A. This Section includes Type II commercial kitchen hoods.

1.3 DEFINITIONS

A. Type II Hood: A hood designed for heat and steam removal and for other nongrease applications.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:
1. Standard hoods.
2. Filters/baffles.
3. Lighting fixtures.

B. Shop Drawings:
1. Shop Drawing Scale: 1/4 inch = 1 foot
2. Show plan view, elevation view, sections, roughing-in dimensions, service requirements, duct connection sizes, and attachments to other work.
3. Show cooking equipment plan and elevation to confirm minimum code-required overhang.
4. Indicate performance, exhaust and makeup air airflow, and pressure loss at actual Project-site elevation.
5. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
6. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D 1.1M, "Structural Welding Code - Steel," for hangers and supports; and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for joint and seam welding.

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. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section 013100 "Project Management and Coordination."

1.7 COORDINATION

A. Coordinate equipment layout and installation with adjacent Work, including lighting fixtures, HVAC equipment, plumbing, and fire-suppression system components.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of kitchen hood that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 2 years from date of substantial completion.

PART 2 - PRODUCTS

2.1 HOOD MATERIALS

A. Stainless-Steel Sheet: Type 430
   1. Minimum Thickness: 0.050 inch
   2. Finish: Comply with SSINA's "Finishes for Stainless Steel" for recommendations for applying and designating finishes.
      a. Finish shall be free from tool and die marks and stretch lines and shall have uniform, directionally textured, polished finish indicated, free of cross scratches. Grain shall run with long dimension of each piece.
   3. Concealed Stainless-Steel Surfaces: ASTM A 480/A 480M, No. 2B finish (bright, cold-rolled, unpolished finish).

B. Sealant: ASTM C 920; Type S, Grade NS, Class 25, Use NT. Elastomeric sealant shall be NSF certified for commercial kitchen hood application. Sealants, when cured and washed, shall comply with requirements in 21 CFR, Section 177.2600, for use in areas that come in contact with food.
   1. Color: As selected by Architect from manufacturer's full range.
   2. Backer Rod: Closed-cell polyethylene, in diameter larger than joint width.

C. Gaskets: NSF certified for end-use application indicated; of resilient rubber, neoprene, or PVC that is nontoxic, stable, odorless, nonabsorbent, and unaffected by exposure to foods and cleaning compounds, and that passes testing according to UL 710.

D. Temperature Switch: Provide temperature sensor/switch in hood outlet to be used to start the hood exhaust fan and associated make-up air unit automatically upon the detection of heat under the hood regardless of the position of the hood exhaust fan manual on-off switch. Controls shall also include a time delay relay to allow the exhaust fan and associated make-up air unit to run for an adjustable time delay off after the exhaust fan is manually shut off to remove residual heat from the cooking appliances under the hood.
   1. Switch shall be UL listed as manufactured by Vulcan (Cal-stat 1C2B9 - 80) or approved equal, with 5/8" diameter 304 stainless steel sensing bulb and adjustment screw with a -100 to 600 deg. F. temperature range.
   2. Sensors shall be mounted to project into exhaust duct collars with quick-seal fittings and terminated in an electrical junction box tack-welded to the face of the exhaust collars.

E. UL listed vapor-proof dome style light fixtures with 100W equivalent compact fluorescent light bulbs.

2.2 GENERAL HOOD FABRICATION REQUIREMENTS

A. Welding: Use welding rod of same composition as metal being welded. Use methods that minimize distortion and develop strength and corrosion resistance of base metal. Make ductile welds free of mechanical imperfections such as gas holes, pits, or cracks.
   1. Welded Butt Joints: Full-penetration welds for full-joint length. Make joints flat, continuous, and homogenous with sheet metal without relying on straps under seams, filling in with solder, or spot welding.
   2. Grind exposed welded joints flush with adjoining material and polish to match adjoining surfaces.
   3. Where fasteners are welded to underside of equipment, finish reverse side of weld smooth and flush.
   4. Coat concealed stainless-steel welded joints with metallic-based paint to prevent corrosion.
   5. After zinc-coated steel is welded, clean welds and abraded areas and apply SSPC-Paint 20, high-zinc-dust-content, galvanizing repair paint to comply with ASTM A 780/A 780M.

B. For metal butt joints, comply with SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines."

C. Where stainless steel is joined to a dissimilar metal, use stainless-steel welding material or fastening devices.

D. Form metal with break bends that are not flaky, scaly, or cracked in appearance; where breaks mar uniform surface appearance of material, remove marks by grinding, polishing, and finishing.

E. Sheared Metal Edges: Finish free of burrs, fins, and irregular projections.

F. Cap exposed fastener threads, including those inside cabinets, with stainless-steel lock washers and stainless-steel cap (acorn) nuts.

G. Fabricate enclosures, including panels, housings, and skirts, to conceal service lines, operating components, and mechanical and electrical devices including those inside cabinets, unless otherwise indicated.

H. Fabricate equipment edges and backsplashes according to SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines."

I. Fabricate enclosure panels to ceiling and wall as follows:
   1. Fabricate panels on four side(s) with same material as hood, and extend from underside of existing duct to top of hood canopy and per the width and depth of the hood indicated on plans.
   2. Wall Offset Spacer: Minimum of 3 inches.

J. Provide integral 1” insulated side panels for any surface that comes in contact with combustible materials to comply with zero clearance to combustibles per NFPA 96.

2.3 TYPE II EXHAUST HOOD FABRICATION

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Air Tech.
   2. Captive-Aire Systems.
   3. Greenheck Fan Corporation.
   4. Halton Company.

B. Fabricate hoods according to NSF 2, "Food Equipment."

C. Fabricate hoods to comply with SMACNA's "HVAC Duct Construction Standards: Metal and Flexible."

D. Hood Configuration: Exhaust only

E. Hood Type: Heat and vapor removal.

F. Hood Style: Structurally hung canopy.

G. Condensate Hood Baffles: Removable, stainless-steel baffles to drain into a hood drain trough, and stainless-steel drain piping.

H. Lighting Fixtures: Surface-mounted, fluorescent fixtures and lamps with lenses sealed vaportight. Wiring shall be installed in stainless-steel conduit on hood exterior. Number and location of fixtures shall provide a minimum of 70 fc at 30 inches above finished floor.
   1. Light switches shall be mounted on front panel of hood canopy
   2. Lighting Fixtures: L55 series.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

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

3.2 INSTALLATION

A. Complete field assembly of hoods where required.
   1. Make closed butt and contact joints that do not require filler.
   2. Grind field welds on stainless-steel equipment smooth, and polish to match adjacent finish. Comply with welding requirements in Part 2 "General Hood Fabrication Requirements" Article.

B. Install hoods and associated services with clearances and access for maintaining, cleaning, and servicing hoods, and filters/baffles according to manufacturer's written instructions and requirements of authorities having jurisdiction.

C. Securely anchor and attach items and accessories to structure above with stainless-steel fasteners, unless otherwise indicated.

D. Install hoods to operate free from vibration.

E. Install trim strips and similar items requiring fasteners in a bed of sealant. Fasten with stainless-steel fasteners at 48 inches o.c. maximum.

F. Install sealant in joints between equipment and abutting surfaces with continuous joint backing, unless otherwise indicated. Provide airtight, watertight, vermin-proof, sanitary joints.

G. Install lamps, with maximum recommended wattage, in equipment with integral lighting.

H. Set initial temperatures, and calibrate sensors.

I. Set field-adjustable temperature switches.

3.3 CONNECTIONS

A. Connect ducts according to requirements in Division 23 Section 233300 "Air Duct Accessories." Weld exhaust-duct connections with continuous liquid tight joint.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. 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.

B. Tests and Inspections:
   1. Test each equipment item for proper operation. Repair or replace equipment that is defective, including units that operate below required capacity or that operate with excessive noise or vibration.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   3. Perform hood performance tests required by authorities having jurisdiction.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

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

END OF SECTION 233813

SECTION 236200 - PACKAGED COMPRESSOR AND CONDENSER 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.

B. Division 23, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 013100 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.

1.2 SUMMARY

A. Section includes installation of packaged, refrigerant compressor and condenser units provided as part of pre-purchase, equipment stand and mounting.

1.3 ACTION SUBMITTALS

A. Product Data: For each equipment stand, include rated capacities, operating characteristics, and furnished specialties and accessories. Include required clearances, method of field assembly, components, and location and size of each field connection.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, 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. Structural members to which compressor and condenser units will be attached.
   2. Liquid and vapor pipe sizes.
   3. Refrigerant specialties.
   4. Piping including connections, oil traps, and double risers.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Standard for Refrigeration Systems."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."

1.6 COORDINATION

A. Coordinate installation of equipment supports, and roof pipe penetrations.

B. Coordinate location of piping and electrical rough-ins.

PART 2 - PRODUCTS

2.1 EQUIPMENT STAND

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Diversitech Heat Pump Stand
   2. RectorSeal Big Foot Stands
   3. Miro Mini Split Rail Support

B. Description: 18” tall, 14 gauge square tubing or channel, powder coated for outdoor use. Hot dip or electro galvanized hardware and brackets for corrosion resistance. Polycarbonate base / legs for mounting on roof surface.

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 compressor and condenser units.

B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where compressor and condenser units will be installed.

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

3.2 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated.

B. Install roof-mounting units on equipment supports listed herein.

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

A. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

B. Connect precharged refrigerant tubing to unit's quick-connect fittings. Install tubing so it does not interfere with access to unit. Install furnished accessories.

C. Connect refrigerant piping to air-cooled compressor and condenser units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Division 23 Section 232300 "Refrigerant Piping."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
   2. Leak Test: After installation, charge system with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor operation and unit operation, product capability, and compliance with requirements.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   5. Verify proper airflow over coils.

C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

D. Compressor and condenser units will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
      a. Inspect for physical damage to unit casing.
      b. Verify that access doors move freely and are weathertight.
      c. Clean units and inspect for construction debris.
      d. Verify that all bolts and screws are tight.

e. Adjust vibration isolation and flexible connections.
f. Verify that controls are connected and operational.

B. Lubricate bearings on fan motors.

C. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.

D. Adjust fan belts to proper alignment and tension.

E. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.

F. Measure and record airflow and air temperature rise over coils.

G. Verify proper operation of condenser capacity control device.

H. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

I. After startup and performance test, lubricate bearings.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain compressor and condenser units.

END OF SECTION 236200

SECTION 237423 – FUEL-FIRED MAKEUP-AIR 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.

B. Division 23, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 013100 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.

1.2 SUMMARY

A. Section includes:
   1. Outdoor direct-fired make up air units.

1.3 DEFINITIONS

A. BAS: Building automation system.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and configuration of makeup-air unit.
   1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each type and configuration of makeup-air unit.
   1. Signed, sealed, and prepared by or under the supervision of a qualified professional engineer.
   2. Include plans, elevations, sections, and mounting details.
   3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   4. Detail fabrication and assembly of gas-fired heating and ventilating units, as well as procedures and diagrams.
   5. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Startup service reports.

B. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For makeup-air units to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: One set(s) for each unit.
   2. Fan Belts: One set(s) for each unit.

1.8 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of direct-fired heating and ventilating units that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Captive-Aire
   2. Greenheck Fan Corporation.
   3. Modine.
   4. Reznor.

2.2 SYSTEM DESCRIPTION

A. Factory-assembled, prewired, self-contained unit consisting of cabinet, supply fan, controls, filters**,** and fuel-fired gas burner.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 UNIT CASINGS

A. General Fabrication Requirements for Casings:
   1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
   2. Casing Joints: Sheet metal screws or pop rivets, factory sealed with water-resistant sealant.
   3. Factory Finish for Galvanized-Steel Casings: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on enamel finish, consisting of prime coat and thermosetting topcoat.
   4. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.
   5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. Configuration: Horizontal unit with bottom discharge for roof-mounting installation.

C. Cabinet: Unit housing shall be constructed of 20 Gauge G-90 galvanized steel. The wall panels and roof panels shall be fabricated by forming double-standing, self-locking seams that require no additional support. The floor and wall panels shall be caulked air tight with a silicone caulk. All casing panels shall be attached with sheet-metal, screws or rivets which can be removed to field service large components. The unit base shall be suitable for curb or flat mount. Housing construction should be suitable for outdoor or indoor installation

D. Discharge Section:
   1. Down-discharge plenum insulated with 1-inch, 1.5-lb. /cu. ft. fibrous glass.

E. Casing Insulation and Adhesive:
   1. Materials: ASTM C 1071, Type I.
   2. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from, and including, the heating-coil section.
      a. Liner Adhesive: Comply with ASTM C 916, Type I.
      b. Mechanical Fasteners: Galvanized steel, suitable for adhesive, mechanical, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
      c. Liner materials applied in this location shall have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric, depending on service-air velocity.

F. Inspection and Access Panels and Access Doors:
   1. Panel and Door Fabrication: Formed and reinforced, single--wall and insulated panels of same materials and thicknesses as casing.
   2. Inspection and Access Panels:
      a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.

b. Gasket: Neoprene, applied around entire perimeters of panel frames.
c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

3. Access Doors:
   a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
   b. Gasket: Neoprene, applied around entire perimeters of panel frames.
   c. Size: At least 18 inches wide by full height of unit casing
4. Locations and Applications:
   a. Fan Section: Doors.
   b. Access Section: Doors.
   c. Burner Section: Inspection and access panels.
   d. Filter Section: Doors large enough to allow periodic removal and installation of filters.

G. Condensate Drain Pans:
1. Fabricated with one percent slope in at least two planes to collect condensate from condensate-producing heat exchangers, and to direct water toward drain connection.
   a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
   b. Depth: A minimum of 2 inches deep.
2. Single-wall, galvanized-steel sheet.
3. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
   a. Minimum Connection Size: NPS 1.
4. Pan-Top Surface Coating: Asphaltic waterproofing compound.

2.4 ACCESSORIES

A. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

B. Electric heater with integral thermostat maintains minimum 50 deg F temperature in gas burner compartment.

C. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.

2.5 OUTDOOR-AIR INTAKE HOOD

A. Type: Manufacturer's standard hood or louver.

B. Materials: Match cabinet.

C. Bird Screen: Comply with requirements in ASHRAE 62.1.

D. Filter: Aluminum, 1 inch cleanable.

E. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.6 ROOF CURBS

A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
   1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
      a. Materials: ASTM C 1071, Type I or Type II.
      b. Thickness: 1 inch.
   2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
      a. Liner Adhesive: Comply with ASTM C 916, Type I.
      b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
      c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
      d. Liner Adhesive: Comply with ASTM C 916, Type I.

B. Curb Height: 14 inches

2.7 SUPPLY-AIR FAN

A. Fan Type: Forward curved, centrifugal, double width, double inlet, constructed G-90 galvanized steel. Unit shall have a heavy-duty, solid-steel shaft. Wheels shall be balanced in two planes and done in accordance with AMCA standard 204-96, *Balance Quality and Vibration Levels for Fans*. The wheel blades shall be aerodynamically designed to minimize turbulence, increase efficiency and reduce noise. The wheel blades shall be securely attached to the wheel inlet ring. The wheel shall be firmly attached to the fan shaft with set screws and keys.

B. Shaft and Bearings: Shafts shall be precision ground and polished. Heavy duty, pre-lubricated bearings shall be selected for a minimum (L50) life in excess of 200,000 hours of operation at maximum cataloged operating speed. They shall be designed for, and individually tested specifically for use in air handling applications.

C. Drive: Belts shall be oil and heat resistant, non-static, grip-notch type. Drives shall be cast type, precision machined and keyed and secured attached to the fan and motor shafts. Fan operating speed shall be factory set using adjustable pitch motor pulleys. Blower drives shall be fully adjustable. All drives shall be a minimum of 2 groove above 2 HP.

D. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with restrained**,** isolators.

E. Fan-Shaft Lubrication Lines: Extended to a location outside the casing.

2.8 AIR FILTERS

A. Disposable Panel Filters: Factory-fabricated, flat-panel-type, disposable air filters with holding frames**,** with a MERV 8 according to ASHRAE 52.2.
   1. Thickness: 1 inch.
   2. Media: Interlaced glass fibers.
   3. Frame: Galvanized steel.

2.9 DAMPERS

A. Outdoor-Air Damper: Galvanized-steel, opposed-blade dampers with vinyl blade seals and stainless-steel jamb seals, having a maximum leakage of 10 cfm/sq. ft. of damper area, at a differential pressure of 2-inch w.g.

B. Damper Operator: Direct coupled, electronic with spring return or fully modulating as required by the control sequence.

2.10 DIRECT-FIRED GAS BURNER

A. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47, "Gas-Fired Central Furnaces," and with NFPA 54, "National Fuel Gas Code."
   1. CSA Approval: Designed and certified by and bearing label of CSA.
   2. Burners: Stainless steel.
      a. Gas Control Valve: Modulating.
      b. Fuel: Natural gas.
      c. Minimum Combustion Efficiency: 95 percent.
      d. Ignition: Electronically controlled electric spark with flame sensor.

B. Safety Controls:
   1. Control Transformer: 24-V ac.
   2. High Limit: Thermal switch or fuse to stop burner.
   3. Gas Train: Regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, electronic-modulating temperature control valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
   4. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
   5. Gas Manifold: Safety switches and controls complying with ANSI standards.
   6. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
   7. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
   8. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.

2.11 UNIT CONTROL PANEL

A. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.

B. Control Panel: remote panel, with engraved plastic cover and the following lights and switches:
   1. On-off-auto fan switch.
   2. Heat-vent-off switch.
   3. Supply-fan operation indicating light.
   4. Heating operation indicating light.
   5. Thermostat.
   6. Damper position potentiometer.
   7. Dirty-filter indicating light operated by unit-mounted differential pressure switch.
   8. Safety-lockout indicating light.
   9. Enclosure: NEMA 250, Type 3R.

2.12 CONTROLS

A. Comply with requirements in Division 23 Section 230900 "Instrumentation and Control for HVAC".

B. Control Devices:
   1. Remote Thermostat: Adjustable room thermostat with temperature readout.
   2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
   3. Timers: Solid-state, programmable time control with four separate programs; 24-hour battery carryover; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; and system fault alarm.

C. Fan Control: Interlock fan to start with exhaust fan(s) to which this heating and ventilating unit is associated for makeup air.

D. Outdoor-Air Damper Control, 100 Percent Outdoor-Air Units: Outdoor-air damper shall prove prior to supply fan start, and close after fan stops.

E. Temperature Control: Operates gas valve to maintain space-air temperature.
   1. Operates gas valve to maintain space temperature with wall-mounting, field-wired sensor with temperature adjustment.
   2. Burner Control: 20 to 100 percent modulation of the firing rate.

F. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display status and alarms of heating and ventilating unit.
   1. Hardwired Points:
      a. Room temperature.
      b. Discharge-air temperature.
      c. Burner operating.

2. ASHRAE 135.1 (BACnet) communication interface with the BAS shall enable the BAS operator to remotely control and monitor the heating and ventilating unit from an operator workstation. Control features and monitoring points displayed locally at heating and ventilating unit control panel shall be available through the BAS.

2.13 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section 230513 "Common Motor Requirements for Mechanical Equipment."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of piping and electrical connections before equipment installation.

C. Verify cleanliness of airflow path to include inner-casing surfaces, filters, coils, turning vanes, fan wheels, and other components.

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

3.2 INSTALLATION

A. Install gas-fired units according to NFPA 54, "National Fuel Gas Code."

B. Install controls and equipment shipped by manufacturer for field installation with make-up air units.

C. Roof Curb: Install on roof structure, level and secure. Install units on curbs and coordinate roof penetrations and flashing with arch trades. Secure units to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.
   1. Gas Piping: Comply with requirements in Division 23 Section 231123 "Facility Natural-Gas Piping." Connect gas piping with shutoff valve and union, and with sufficient clearance for burner removal and service. Make final connections of gas piping to unit with corrugated, stainless-steel tubing flexible connectors complying with ANSI LC 1/CSA 6.26 equipment connections.

B. Where installing piping adjacent to make-up air units, allow space for service and maintenance.

C. Duct Connections: Connect supply ducts to direct-fired heating and ventilating units with flexible duct connectors. Comply with requirements in Division 23 Section 233300 "Air Duct Accessories" for flexible duct connectors.

D. Connect wiring according to Division 26 Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Units will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
   1. Inspect for visible damage to burner combustion chamber.
   2. Inspect casing insulation for integrity, moisture content, and adhesion.
   3. Verify that clearances have been provided for servicing.
   4. Verify that controls are connected and operable.
   5. Verify that filters are installed.
   6. Purge gas line.
   7. Verify bearing lubrication.
   8. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
   9. Adjust fan belts to proper alignment and tension.

C. Start unit according to manufacturer's written instructions.
   1. Complete startup sheets and attach copy with Contractor's startup report.
   2. Inspect and record performance of interlocks and protective devices; verify sequences.
   3. Operate unit for run-in period recommended by manufacturer.
   4. Perform the following operations for both minimum and maximum firing, and adjust burner for peak efficiency:
      a. Measure gas pressure at manifold.
      b. Measure combustion-air temperature at inlet to combustion chamber.

c. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

5. Calibrate thermostats.
6. Adjust and inspect high-temperature limits.
7. Inspect dampers, if any, for proper stroke and interlock with return-air dampers.
8. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
9. Measure and record airflow. Plot fan volumes on fan curve.
10. Verify operation of remote panel, including pilot-operation and failure modes. Inspect the following:
    a. High-limit heat.
    b. Alarms.
11. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
12. Verify drain-pan performance.
13. Verify outdoor-air damper operation.

3.6 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to one visits to Project during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain make-up air units.

END OF SECTION 237423

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

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. Division 23, Common Work Results for Mechanical, requirements apply to this section.

C. Division 01 Section 013100 Project Management and Coordination, applies to this section and will require the contractors' participation in the Above Ceiling Coordination Program.

1.2 SUMMARY

A. Section includes split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 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. Filters: One set(s) for each air-handling unit.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:
   1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
   2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.8 COORDINATION

A. Coordinate sizes and locations of equipment stands, and roof penetrations with actual equipment provided.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
   1. Warranty Period:
      a. For Compressor: Five year(s) from date of Substantial Completion.
      b. For Parts: Two year(s) from date of Substantial Completion.
      c. For Labor: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. LG.
   2. Mitsubishi.
   3. Daikin.
   4. Panasonic.

2.2 INDOOR UNITS (5 TONS OR LESS)

A. Wall-Mounted, Evaporator-Fan Components:
   1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
   2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
   3. Fan: Direct drive, centrifugal.
   4. Fan Motors:
      a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 20 Section 200513 "Common Motor Requirements for Mechanical Equipment."
      b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
      c. Enclosure Type: Totally enclosed, fan cooled.
      d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
      e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
      f. Mount unit-mounted disconnect switches on exterior of unit.
   5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   6. Condensate Drain Pans:
      a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
         1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
         2) Depth: A minimum of 1 inch deep.
      b. Single-wall, stainless-steel sheet.
      c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
         1) Minimum Connection Size: NPS 1.
      d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
   7. Air Filtration Section:
      a. General Requirements for Air Filtration Section:
         1) Comply with NFPA 90A.
         2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:
   1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
   a. Compressor Type: Scroll.
   b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
   c. Refrigerant Charge: R-410A
   d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
3. Fan: Aluminum-propeller type, directly connected to motor.
4. Motor: Permanently lubricated, with integral thermal-overload protection.
5. Low Ambient Kit: Permits operation down to 0 deg F.
6. Mounting Stand: Aluminum (See schedule)

2.4 ACCESSORIES

A. Control equipment and sequence of operation are specified in Division 23 Section 230900 "Instrumentation and Control for HVAC."

B. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
   1. Compressor time delay.
   2. 24-hour time control of system stop and start.
   3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
   4. Fan-speed selection including auto setting.

C. Automatic-reset timer to prevent rapid cycling of compressor.

D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

E. Drain Hose: For condensate.

F. Additional Monitoring:
   1. Monitor constant and variable motor loads.
   2. Monitor variable-frequency-drive operation.
   3. Monitor economizer cycle.
   4. Monitor cooling load.
   5. Monitor air distribution static pressure and ventilation air volumes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports indicated on schedule. Anchor units to supports with removable, cadmium-plated fasteners.

D. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

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

END OF SECTION 238126

SECTION 260010 - GENERAL REQUIREMENTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Division 01, Commissioning Requirements, applies to this section and will require the contractor participation in the commissioning process.

C. Division 01 Section “LEED Requirements.”

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for electrical systems provided under CSI Divisions 26, 27 and 28. The following requirements are included in this Section to supplement the requirements specified in Division 1 Specification Sections.

1.3 QUALITY ASSURANCE

A. Scope of Work: Furnish all labor, material, equipment, technical supervision, and incidental services required to complete, test and leave ready for operation the electrical systems as specified in the Divisions 26, 27 and 28 Specification sections and as indicated on Drawings.

B. Codes and Standards: Perform all Work in accordance with applicable Federal, State and local codes rules, ordinances and regulations. The electrical and physical properties of all materials, and the design, performance characteristics, and methods of construction of all items of equipment, shall be in accordance with the latest issue of the various, applicable Standards, Rules and Regulations of NFPA, NECA, UL, and as follows unless otherwise indicated.
   1. A.N.S.I. - American National Standards Institute
   2. A.S.T.M. - American Society for Testing Materials
   3. I.C.E.A. - Insulated Cable Engineers Association
   4. I.E.E.E. - Institute of Electrical and Electronics Engineers
   5. N.E.C. - National Electrical Code
   6. N.E.C.A. -National Electrical Contractors Association
   7. N.E.M.A. - National Electrical Manufacturer's Association

8. U.L. - Underwriters Laboratories, Inc.
9. N.E.C.A. 1-2000, “Practices for Good Workmanship in Electrical Contracting (ANSI).”

C. Where available products included in the work shall “Listed” or “Certified” by a nationally recognized testing laboratory. The listing or certification shall be acceptable to the authority having jurisdiction. The listing or certification shall indicate that the product’s safety-related standards have been evaluated with regard to all reasonably foreseeable safety-related hazards, including fire, electrical shock and mechanical hazards.

D. Notify the Architect/Engineer before submitting a proposal should any changes in Drawings or Specifications be required to conform to the above codes, rules or regulations. After entering into Contract, make all changes required to conform to above ordinances, rules and regulations without additional expense to the Owner.

E. All materials shall be new unless indicated otherwise to reuse existing equipment.

F. Source Limitations: All equipment of the same or similar systems shall be by the same manufacturer.

G. Tests and Inspections: Perform all tests required by state, city, county and/or other agencies having jurisdiction. Provide all materials, equipment, etc., and labor required for tests.

H. Performance Requirements: Perform all work following practices for good workmanship, in accordance with the latest accepted standards and practices for the trades involved.

I. Sequence and Schedule: Work so as to avoid interference with the work of other trades. Be responsible for removing and relocating any work which in the opinion of the Owner’s Representatives causes interference.

1.4 CODES, PERMITS AND FEES

A. Unless otherwise indicated, all required permits, licenses, inspections, approvals and fees for electrical work shall be secured and paid for by the Contractor.

B. DRAWINGS

C. The Drawings show the location and general arrangement of equipment, electrical systems and related items. They shall be followed as closely as elements of the construction will permit.

D. Examine the Drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly, providing such fittings, conduit, junction boxes and accessories as may be required to meet such conditions.

E. Deviations from the Drawings, with the exception of minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect/Engineer.

F. The architectural and structural Drawings take precedence in all matters pertaining to the building structure, mechanical Drawings in all matters pertaining to mechanical trades and electrical Drawings in all matters pertaining to electrical trades. Where there are conflicts or differences between the Drawings for the various trades, report such conflicts or differences to the Architect/Engineer for resolution.

G. Drawings are not intended to be scaled for rough-in or to serve as shop drawings. Take all field measurements required to complete the Work.

1.5 MATERIAL AND EQUIPMENT MANUFACTURERS

A. All items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new and shall be standard products of manufacturers regularly engaged in the production of electrical equipment and shall be of the manufacturer's latest design.

B. If an approved manufacturer is other than the manufacturer used as the basis for design, the equipment or product provided;
   1. Shall be equal in size, quality, durability, appearance, capacity, and efficiency through all ranges of operation,
   2. Shall conform with arrangements and space limitations of the equipment shown on the plans and/or specified,
   3. Shall be compatible with the other components of the system,
   4. Shall be by the same manufacturer, and
   5. Shall comply with the requirements for Items Requiring Prior Approval specified in this section of the Specifications.

   All costs to make these items of equipment comply with these requirements including, but not limited to, electrical work, mechanical work, controls work, technology work and building alterations shall be included in the original Bid.

1.6 INSPECTION OF SITE

A. Visit the site, examine and verify the conditions under which the Work must be conducted before submitting Proposal. The submitting of a Proposal implies that the Contractor has visited the site and understands the conditions under which the Work must be conducted. No additional charges will be allowed because of failure to make this examination or to include all materials and labor to complete the Work.

1.7 ITEMS REQUIRING PRIOR APPROVAL

A. Bids shall be based upon manufactured equipment specified. All items that the Contractor proposes to use in the Work that are not specifically named in the Contract Documents must be submitted for review prior to bids. Such items must be submitted in compliance with Division 1 specifications. Requests for prior approval must be accompanied by complete catalog information, including but not limited to, model, size, accessories, complete electrical information and performance data in the form given in the equipment schedule on the drawings at stated design conditions. Where items are referred to by symbolic designations on the drawings, all requests for prior approval shall bear the same designations.
   1. Equipment to be considered for prior approval shall be equal in quality, durability, appearance, capacity and efficiency through all ranges of operation, shall fulfill the requirements of equipment arrangement and space limitations of the equipment shown on the plans and/or specified and shall be compatible with the other components of the system.
   2. All costs incurred to make equipment comply with other requirements, including providing maintenance, clearance, electrical, replacement of other components, and building alterations shall be included in the original bid.

B. Voluntary alternates may be submitted for consideration, with listed addition or deduction to the bid.

1.8 SHOP DRAWINGS/SUBMITTALS

A. Submit project-specific submittals for review in compliance with Division 1.

B. All shop Drawings shall be submitted in groupings of similar and/or related items (lighting fixtures, switchgear, etc.). Incomplete submittal groupings will be returned unchecked.

C. If deviations (not substitutions) from Contract Documents are deemed necessary by the Contractor, details of such deviations, including changes in related portions of the project and the reasons therefore, shall be submitted with the submittal for approval.

D. Submit for approval shop drawings for all electrical systems and equipment as listed below. Where items are referred to by symbolic designation on the Drawings and in the Specifications, all submittals shall bear a similar designation (light fixtures, wiring devices, etc.) as identified on the Drawings and in the Specifications and shall be submitted together and under the same cover, unless requested otherwise. Refer to other sections of the electrical Specifications for additional requirements.
   1. Medium Voltage Transformers
   2. Low Voltage Switchgear or Switchboards
   3. Labeling Concept List
   4. Lighting Controls
   5. Wiring Devices
   6. Enclosed Controllers
   7. Panelboards
   8. Engine Generator
   9. Transfer Switches
   10. Interior Lighting
   11. Dimming Controls
   12. Interior Lighting
   13. Exterior Lighting
   14. Fire Alarm

1.9 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS

A. Submit project specific Operation and Maintenance Instructional Manuals for review in compliance with Division 1 Specification Sections.

B. Provide complete operation and maintenance instructional manuals covering all electrical equipment herein specified, together with parts lists. Maintenance and operating instructional manuals shall be job specific to this project. Generic manuals are not acceptable. Four (4) copies of all literature shall be furnished for Owner and shall be bound in ring binder form. Maintenance and operating instructional manuals shall be provided when construction is approximately 75% complete.

C. The operating and maintenance instructions shall include a brief, general description for all mechanical systems including, but not limited to:
   1. Routine maintenance procedures.
   2. Lubrication chart listing all types of lubricants to be used for each piece of equipment and the recommended frequency of lubrication.
   3. Trouble-shooting procedures.
   4. Contractor's telephone numbers for warranty repair service.
   5. Submittals.
   6. Recommended spare parts lists.
   7. Names and telephone numbers of major material suppliers and subcontractors.
   8. System schematic drawings on 8-1/2" x 11" sheets.

1.10 RECORD DRAWINGS

A. Submit record drawings in compliance with Division 1.

B. Contractor shall submit to the Architect/Engineer, record drawings on portable device format (pdf) which have been neatly marked to represent as-built conditions for all new electrical work.

C. The Contractor shall keep accurate note of all deviations from the construction documents and discrepancies in the underground concealed conditions and other items of construction on field drawings as they occur. The marked-up field documents shall be available for review by the Architect, Engineer and Owner at their request.

1.11 INSTRUCTION OF OWNER PERSONNEL

A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of electrical equipment and systems at agreed upon times. A minimum of 8 hours of formal instruction to Owner's personnel shall be provided for each building. Additional hours are specified in individual specification sections.

B. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

C. In addition to individual equipment training provide overview of each electrical system. Utilize the as-built documents for this overview.

D. Prepare and insert additional data in operation and maintenance manual when need for such data becomes apparent during instruction, or as requested by Owner.

1.12 WARRANTY

A. Warranty: Comply with the requirements in Division 1 Specification Sections. Contractor shall warranty that the electrical installation is free from defects and agrees to replace or repair, to the Owner’s satisfaction, any part of this electrical installation which becomes defective within a period of one year (unless specified otherwise in other Division 26, 27 or 28 sections) from the date of substantial completion following final acceptance, provided that such failure is due to defects in the equipment, material, workmanship or failure to follow the contract documents.

B. Contractor shall be responsible for any and all temporary services including equipment and installation required to maintain operation as a result of any equipment failure or defect during warranty period.

C. File with the Owner any and all warranties from the equipment manufacturers including the operating conditions and performance capacities they are based on.

1.13 USE OF EQUIPMENT

A. The use of any equipment, or any part thereof for purposes other than testing even with the Owner's consent, shall not be construed to be an acceptance of the work on the part of the Owner, nor be construed to obligate the Owner in any way to accept improper work or defective materials.

B. Do not use Owner's lamps for temporary lighting except as allowed and directed by the Owner. Equip lighting fixtures with new lamps when the project is turned over to the Owner.

1.14 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical 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 electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."

D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

1.15 ELECTRICAL COMMISSIONING

A. RELATED DOCUMENTS
1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section. Refer to Division 01 Section “General Commissioning
2. Requirements” for detailed explanation of commissioning work. Section also contains sample Cx Plan, construction checklist, and functional test.

B. 1.2 SUMMARY

1. The following electrical systems to be commissioned. The commissioning process is described in detail in the commissioning plan (Refer to Division 01 Section “General Commissioning Requirements”).

C. SYSTEMS TO BE COMMISSIONED

1. The following systems will be commissioned:
2. Conductors and Cables 600V and below.
3. Grounding and Bonding.
4. Overcurrent Protective Device Coordination Study.
5. Padmount, Liquid Filled, Medium Voltage Transformers.
6. Low Voltage Distribution Transformers.
7. Switchboards.
8. Panelboards.
9. Low Voltage Circuit Protective Devices
10. Fire Detection and Alarm

PART 2 - PRODUCTS (NOT APPLICABLE.)

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items. If mounting heights are not indicated, install to provide maximum possible physical space for access after installation without adding a hazardous situation. Contact the Architect for direction.

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 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.

E. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 DEMOLITION WORK

A. All demolition of existing electrical equipment and materials will be done by this Contractor unless otherwise indicated. Include all items such as, but not limited to, electrical equipment, devices, lighting fixtures and associated conduit and wiring called out on the Drawings and as necessary whether such items are actually indicated on the Drawings or not in order to accomplish the installation of the specified new work. Remove abandoned wire and cable. Remove abandoned raceways unless removal will require extensive building wall or structure to be removed which was not part of the work. Abandoned raceways to remain shall be left in a safe and finished condition.

B. In general, demolition work is indicated on the Drawings. However, the Contractor shall visit the job site to determine the full extent and character of this work.

C. Unless specifically noted to the contrary, removed materials shall not be reused in the work. Salvaged materials that are to be reused shall be stored safe against damage and turned over to the appropriate trade for reuse. Salvaged materials of value that are not to be reused shall remain the property of the Owner unless such ownership is waived. Items on which the Owner waives ownership shall become the property of the Contractor, who shall remove and legally dispose of same, away from the premises.

D. Where equipment or fixtures are removed, outlets shall be properly blanked off, and conduits capped. After alterations are done, the entire installation shall present a "finished" look, as approved by the Architect/Engineer. The original function of the present electrical work to be modified shall not be changed unless required by the specific revisions to the system as specified or as indicated.

E. Appropriately reroute lighting, power and technology wiring as required to maintain service to equipment and devices to remain. Where walls and ceilings are to be removed, the conduit is to be cut off by the Electrical Trades so that the abandoned conduit in these walls and ceilings may be safely removed. Plug the ends of conduits which cannot be removed and cannot be reused.

F. Where new walls and/or floors are installed which interfere with existing outlets, devices, etc., the Electrical Trades shall adjust, extend and reconnect such items as required to maintain continuity of same.

G. All electrical work in altered and unaltered areas shall be run concealed in finished spaces. Use of surface raceway or exposed conduits will be permitted only where approved by the Architect/Engineer.

H. Existing lighting shall be reused where indicated on plans. Reused fixtures shall be detergent cleaned, re-lamped and reconditioned suitable for satisfactory operation and appearance.

3.3 INSTALLATION OF EQUIPMENT

A. Install all equipment in strict accordance with all directions and recommendations furnished by the manufacturer. Where such directions are in conflict with the Drawings and Specifications, report such conflicts to the Architect/Engineer for resolution.

B. Prior to rough in, allow for flexibility, ten feet in any direction, in the final location of electrical system and wiring devices without additional cost to the Owner.

3.4 WORK IN EXISTING BUILDINGS

A. The Owner will provide access to existing buildings as required. Access requirements to occupied buildings shall be identified on the project schedule. The Contractor, once Work is started in the existing building, shall complete same without interruption so as to return work areas as soon as possible to Owner.

B. Adequately protect and preserve all existing and newly installed Work. Promptly repair any damage at Contractor's expense.

C. Consult with the Owner’s Representative as to the methods of carrying on the Work so as not to interfere with the Owner's operation any more than absolutely necessary. Accordingly, all service lines shall be kept in operation as long as possible and the services shall only be interrupted at such time as will be designated by the Owner's Representative.

D. Prior to starting work in any area, obtain approval for doing so from a qualified representative of the Owner who is designated and authorized by the Owner to perform testing and abatement of all hazardous materials including but not limited to, asbestos. The Contractor shall not perform any inspection, testing, containment, removal or other work that is related in any way whatsoever to hazardous materials under the Contract.

3.5 TEMPORARY SERVICES

A. Provide and remove upon completion of the project, in accordance with the general conditions and as described in Division 1, complete temporary electrical and telecommunication (voice/data) services for use during construction.

3.6 DISPOSAL

A. Fluorescent Lamps
   1. Fluorescent lamps are known to contain mercury and are classified as hazardous material. All fluorescent lamps shall be assumed to contain mercury unless tested and confirmed otherwise with a toxicity characteristic leaching procedure (TCLP).
   2. Hazardous materials, including fluorescent lamps, shall be sent to a lamp recycling facility. The materials shall be properly packaged with labels that meet the Department of Transportation Regulations and stored in a secure location prior to transportation.
   3. The Contractor shall identify the costs of the lamp disposal process including, but not limited to, the lamp packaging, storage, transportation, disposal, and any profile fees.
   4. At the completion of the project, provide documentation to verify that the lamps have been properly disposed of in accordance with all local, state and federal guidelines.

B. Ballasts
   1. Lighting ballasts manufactured prior to 1979 have been known to contain polychlorinated biphenyls (PCBs). Unless specifically noted on the ballast as containing "No PCBs," the ballast shall be assumed to contain components with PCB materials.
   2. Hazardous materials (ballasts with PCBs), shall be disposed of at a hazardous waste incineration facility, or at a recycling facility in accordance with the Code of Federal Regulations as administered by the EPA in regards to this issue. The ballasts shall be packaged/stored in fifty-five-gallon steel drums with labels that meet the Department of Transportation Regulations.
   3. The Contractor shall identify the costs of the ballast disposal process including, but not limited to, the packaging, storage, transportation, disposal, and any profile fees.
   4. Provide at completion of the project documentation (manifests) to verify that the ballasts have properly been disposed of in accordance with all local, state and federal guidelines.

3.7 ACCESS DOORS, CHASES AND RECESSES

A. Provided by the architectural trades, but the Contractor shall be responsible for their accurate location and size.

3.8 CUTTING, PATCHING AND DAMAGE TO OTHER WORK

A. Refer to General Conditions for requirements.

B. All cutting, patching and repair work shall be performed by the Contractor through approved, qualified subcontractors. Contractor shall include full cost of same in bid.

3.9 EQUIPMENT CONNECTIONS

A. As included in the work, make connections to equipment, motors, elevator controllers and associated equipment, lighting fixtures, and other items included in the work in accordance with the approved shop Drawings and rough-in measurements furnished by the manufacturers of the particular equipment furnished. All additional connections not shown on the Drawings, but called out by the equipment manufacturer's shop Drawings shall be provided.

3.10 CLEANING

A. All debris shall be removed daily as required to maintain the work area in a neat, orderly condition.

B. Final cleanup shall include, but not be limited to, washing of fixture lenses or louvers, switchboards, substations, motor control centers, panels, etc. Fixture reflectors and lenses or louvers shall be left with no water marks or cleaning streaks.

3.11 PROTECTION AND HANDLING OF EQUIPMENT AND MATERIALS

A. Equipment and materials shall be protected from theft, injury or damage.

B. Protect conduit openings with temporary plugs or caps.

C. Provide adequate storage for all equipment and materials delivered to the job site. Location of the space will be designated by the Owner's representative or Architect/Engineer. Equipment set in place in unprotected areas must be provided with temporary protection.

3.12 EXTRA WORK

A. For any extra electrical work which may be proposed, this Contractor shall furnish to the Construction Manager, an itemized breakdown of costs as described in Specification Section 01 22 00. Proceed only after receiving a written order from the Construction Manager establishing the agreed price and describing the work to be done.

3.13 DRAWINGS AND MEASUREMENTS

A. These Specifications and accompanying Drawings are intended to describe and provide for finished work. They are intended to be cooperative, and what is called for by either shall be as binding as if called for by both. The Contractor understands that the work herein described shall be complete in every detail.

B. The Drawings are not intended to be scaled for rough-in measurements or to serve as Shop Drawings. Field measurements necessary for ordering materials and fitting the installation to the building construction and arrangement are the Contractor's responsibility. The Contractor shall check latest Architectural Drawings and locate light switches from same where door swings are different from Electrical Drawings.

END OF SECTION 260010

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

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. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Grout.
5. Common electrical installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical 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 electrical 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 water stop, 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. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. 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: Plastic. 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 ELECTRICAL 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 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.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 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
   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 electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 26 0500

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.

B. Related Sections include the following:

   1. Division 26 Section "Medium-Voltage Cables" for single-conductor and multi-conductor cables, cable splices, and terminations for electrical distribution systems with 2,001 to 35,000 V.
   2. Division 27 Section “Communications Horizontal Cabling” for cabling used for voice and data circuits.

1.3 SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.5 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

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 General Cable Corporation.
   2. Senator Wire & Cable Company.
   3. Southwire Company.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN, XHHW, and SO.
   1. Unless specifically indicated otherwise, conductors below 4/0 shall have type THHN/THWN insulation. Conductors 4/0 and larger shall have type XHHW insulation.

D. Multi-conductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC, and Type SO with ground wire. Metal-clad cable armor shall be steel.

E. Fire-resistive Cable: Comply with NEMA WC 70. Cable shall be UL labeled as 2-hour fire-rated, type MI mineral-insulated with nickel-clad copper conductor, magnesium oxide insulation, copper alloy sheath, and rated 600 volts. Provide factory installed terminations or field termination kits from the same manufacturer as the cable.
   1. Pentair Pyrotenax
   2. In lieu of the mineral-insulated cable above, a 2-hour fire rated metal clad cable may be substituted. Provide RSCC & Cable VITALink.

F. VFD Cable
   1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.
   2. Type TC-ER with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.

2.2 CONNECTORS AND SPLICES

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. AFC Cable Systems, Inc.
   2. Hubbell Power Systems, Inc.
   3. O-Z/Gedney; EGS Electrical Group LLC.
   4. 3M; Electrical Products Division.
   5. Tyco Electronics Corp.
   6. Thomas & Betts

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Stranded.

B. Branch Circuits: Copper. Unless specifically indicated otherwise, all conductors shall be stranded.

C. Equipment circuits shall be copper, where required by manufacturer's recommendations or direction.

D. Minimum Conductor Sizes:
   1. Feeders and Branch Circuits: No. 12 AWG.
   2. Class 1 Control Circuits: No. 14 AWG.
   3. Class 2 Control Circuits: No. 16 AWG.

E. Unless indicated otherwise, power circuits shall be 2#12, 1#12G, ¾" C.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Provide power conductors in conduit where not protected by a box, enclosure or vault.

B. Service Entrance: Single conductors in raceway.

C. Fire Pump Service Entrance: Single conductors in raceway, installed below floor slab or installed in at least 3 inches of concrete, or 2-hour fire-resistive cable.

D. Exposed Feeders: Single conductors in raceway.

E. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Single conductors in raceway.

F. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Single conductors in raceway.

G. Exposed Branch Circuits, including in Crawlspaces: Single conductors in raceway.

H. Branch Circuits Concealed in Inaccessible Ceilings, Walls, and Partitions: Single conductors in raceway.

I. Branch Circuits in Accessible Ceiling Spaces:
   1. Single conductors in raceways, or
   2. Type MC Cable in lengths 6'-0" or less and for use as a master slave connection between light fixtures.

~~J.~~ Branch Circuits Gypsum-Board Partitions: Single conductors in raceways, or metal-clad cable, Type MC**.** for vertical drops to outlet boxes. MC shall not be used for switch box connections or installed horizontally between boxes.

K. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Single conductors in raceway.

L. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

M. Class 1 Control Circuits: Single conductors in raceway.

N. Class 2 Control Circuits: Type THHN-THWN, in raceway, Power-limited cable, concealed in building finishes (not allowed in exposed ceiling of finished spaces), or Power-limited tray cable, in cable tray.

O. Motor branch circuits, which include a variable frequency drive (VFD): Provide VFD cable from the source overcurrent protection device to the motor. Shields shall be maintained electrically continuous and shall be terminated to the building ground system.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. For circuits that require a neutral conductor, provide a dedicated neutral back to the source overcurrent protective device.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values. Secure pulling points to structurally sound members. Mechanical piping shall not be used under any circumstances to secure pulling points.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, which will not damage cables or raceway.

D. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

E. Do not install conductors supplied from different panelboards, distribution panels, or switchboards in same conduit or raceway, unless otherwise noted.

F. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

G. Install cables parallel and perpendicular to surfaces of structural members and follow surface contours where possible.

H. Do not route cables directly into panelboards, switchboards, motor starting equipment and similar equipment.

I. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Underground splices are prohibited.

D. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance conductors and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements.
      a. Conductors to the Emergency or Standby Generator.
      b. Conductors to the Fire Pump.
   2. Perform each electrical, visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification, including but not limited to the following:
      a. Bolted connection resistance,
      b. Insulation resistance with respect to ground and adjacent conductors,
      c. Continuity verification,
      d. Phase verification,
      e. Resistance of parallel conductors.

   3. Certify compliance with test parameters.

C. Test Reports: Prepare a written report to record the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

3.7 VOLTAGE DROP

A. Voltage drop shall not exceed two percent for feeder conductors.

B. Voltage drop shall not exceed three percent for branch conductors. Refer to table below for maximum permitted branch conductor lengths at rated voltages for indicated OCP. Where lengths are exceeded due to revised routing, calculate the voltage drop and provide the appropriate conductor size to achieve the maximum allowable voltage drop.

Voltage Configuration	#12 AWG 20 amp OCP	#10 AWG 20 amp OCP	#10 AWG 30 amp OCP	#8 AWG 40 amp OCP	#6 AWG 50 amp OCP
120V, single phase	56 feet	93 feet	62 feet	72 feet	91 feet
208V, single phase	97 feet	162 feet	108 feet	124 feet	159 feet
240V, single phase	112 feet	187 feet	125 feet	144 feet	183 feet
277V, single phase	129 feet	216 feet	144 feet	166 feet	211 feet
480V, single phase	225 feet	374 feet	249 feet	288 feet	367 feet
208V, three phase	112 feet	187 feet	100 feet	115 feet	133 feet
240V, three phase	103 feet	173 feet	125 feet	144 feet	183 feet
480V, three phase	259 feet	433 feet	288 feet	333 feet	424 feet

Note: Table assumptions include copper conductors at 80% load capacity, 1.0 power factor, 75ºC temperature rating, EMT conduit, and three percent voltage drop.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

This Section includes methods and materials for grounding systems and equipment plus

1. Underground distribution grounding.
2. Grounding buses

1.3 SUBMITTALS

A. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
   1. Ground rods.
   2. Ground rings.

B. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
   1. Solid Conductors: ASTM B 3.
   2. Stranded Conductors: ASTM B 8.
   3. Tinned Conductors: ASTM B 33.

4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Rectangular bars of annealed copper, 24" L by 1/4"D by 2"H, unless otherwise indicated; with insulators.

2.2 CONNECTORS

A. Manufacturers:
1. Thomas & Betts
2. Burndy

B. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

C. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
1. Pipe Connectors: Clamp type, sized for pipe.

D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

E. Compression Connectors: Irreversible, factory filled with an oxide inhibitor. Connectors must comply with IEEE837, UL467 and CSA22.2

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: stranded unless otherwise indicated.

B. Ground Ring and Ground Mat
1. Provide a #4/0 bare copper ground conductor to connect the grounding rod electrodes or ufer ground electrodes to the ground mat and the perimeter ground bus in the Main Switchgear SWGR-1 room.
2. Provide a ground mat consisting of eight 10' ground rods exothermically connected with #4/0 bare copper conductor under the generator and medium voltage transformer. Connect the ground mat with #4/0 bare copper conductor to the medium voltage transformer, the generator, the ground ring and the perimeter ground bus in the Main Switchgear SWGR-1 room.

C. Grounding Bus: Install in MDF and IDF rooms, and elsewhere as indicated.
   1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.
   2. In the Switchgear Room SWGR-1, provide the perimeter ground bus on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus. All bus to bus connections shall be welded.

D. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground or Encased in Concrete Connections: Welded or compression, except at test wells and as otherwise indicated.
   3. Aboveground and exposed: Welded or compression connectors except at test wells and as otherwise indicated.
   4. Connections to Ground Rods at Test Wells: Bolted connectors.
   5. Connections to Structural Steel: Welded connectors.
   6. Compression connectors shall be installed with the same manufactures die so that the die index matches the listed index on the connector. Connector must be fully crimped with a 14 ton or larger hydraulic tool so that the index number is indented on the connector.

3.2 EQUIPMENT GROUNDING

A. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

B. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

C. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

D. Signal and Communication Equipment: For data equipment rooms, MDF and IDF rooms, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from the equipment room ground bus to the ground bus in the Main Switchgear SWGR-1 room.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

C. Wiring Devices:
   1. Install a 6 inch (150mm) green insulated pigtail from grounding terminal of wiring device to device box and equipment grounding conductor.
   2. For lighting fixtures, install insulated grounding conductor and terminate to terminal on lighting fixture housing.
   3. For electric motors, install an insulated equipment grounding conductor in the branch circuit serving each electric motor, and bond to motor frame.

D. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
   3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

F. Grounding for Steel Building Structure: Install a driven ground rod or create a ufer ground electrode at the base of every other column around the building perimeter at distances not more than 60 feet apart. Install tinned-copper conductor not less than No. 4/0 AWG for tap to building steel.

G. Cable Tray: Provide bonding jumpers to make cable tray electrically continuous throughout. Provide No. 4 AWG minimum insulated copper grounding conductor in raceway from grounding electrode system to cable tray system, bonded to cable tray indicated on the Technology Drawings.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal and at individual ground rods. Make tests at ground rods before any conductors are connected.
      a. Measure ground resistance not less than two full days after last trace of precipitation and without 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.
      b. Perform tests by fall-of-potential method according to IEEE 81.

   3. Prepare dimensioned drawings locating each ground rod, ufer ground 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.

B. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
   2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
   3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms
   4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
   5. Substations and Pad-Mounted Equipment: 5 ohms.
   6. Manhole Grounds: 10 ohms.

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify the Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with equipment manufacturer. 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 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems (Adjustable and Fixed Length): 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. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. ERICO International Corporation.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut; Tyco International, Ltd.
   g. Wesanco, Inc.

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.

B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16 inch-diameter holes at a maximum of 8 inches o.c. in at least 1 surface.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Tube and Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. Fabco Plastics Wholesale Limited.
   d. Seasafe, Inc.

2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
4. Rated Strength: Selected to suit 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) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        3) MKT Fastening, LLC.
        4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

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.; a division of Cooper Industries.
        2) Empire Tool and Manufacturing Co., Inc.
        3) Hilti Inc.
        4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        5) MKT Fastening, LLC.

3. 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.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1,NECA 101, and the NEC for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where it's Table 1 lists maximum spacings less than stated in 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.
   1. Secure raceways and cables to these supports with clamps approved for the application by an agency acceptable to the authorities having jurisdiction.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. 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.

D. 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.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

F. Adjustable length slotted steel supports shall be clamped to a fixed length, per manufacturer's instructions to maintain weight support restrictions recommended by the manufacturer.

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. Provide concrete bases for floor mounted power distribution equipment in the basement and on the first level.

B. 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.

C. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. 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. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:
   1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes, and underground utility construction.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. IMC: Intermediate metal conduit.

D. LFMC: Liquidtight flexible metal conduit.

E. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Shop Drawings: For the following raceway components, include plans, elevations, sections, details and attachments to other work:
   1. Custom enclosures and cabinets.

1.5 COORDINATION

A. Create Coordination Drawings for use in raceway installation.
   1. Create conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
      a. Structural members in the paths of conduit groups with common supports.
      b. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work limited to, the following:
1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
6. Manhattan/CDT/Cole-Flex.
7. Maverick Tube Corporation.
8. O-Z Gedney; a unit of General Signal.
9. Wheatland Tube Company.
10. Thomas & Betts

B. Rigid Steel Conduit: ANSI C80.1.

C. Aluminum Rigid Conduit: ANSI C80.5.

D. IMC: ANSI C80.6.

E. EMT: ANSI C80.3.

F. FMC: Zinc-coated steel.

G. LFMC: Flexible steel conduit with PVC jacket.

H. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
1. Conduit Fittings for Hazardous (Classified) locations. Comply with UL 886.
2. Fittings:
   a. Set screw for interior use only.
   b. Compression or threaded type for exterior use.
3. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with the provided raceways as required for complete system.

I. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 METAL WIREWAYS

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. Cooper B-Line, Inc.
   2. Hoffman.
   3. Legrand Cablofil
   4. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1 or 4X steel, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Small sizes (4 inches by 4 inches and smaller) shall be hinged type with fastening device. Larger sizes shall be provided with a screw-cover and gasket.

E. Finish: Manufacturer's standard enamel finish.

2.3 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
   2. EGS/Appleton Electric.
   3. Erickson Electrical Equipment Company.
   4. Hoffman.
   5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
   6. O-Z/Gedney; a unit of General Signal.
   7. RACO; a Hubbell Company.
   8. Robroy Industries, Inc.; Enclosure Division.
   9. Scott Fetzer Co.; Adalet Division.
   10. Spring City Electrical Manufacturing Company.
   11. Thomas & Betts Corporation.
   12. Legrand Wiremold
   13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Wireway Manufacturers:
   1. Hoffman
   2. Square D
   3. Lamson & Sessions; Carlon Electrical Products

C. Sheet Metal Outlet and Device Boxes: NEMA OS 1, one piece cold drawn type, welded boxes are not acceptable.

D. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

E. Metal Floor Boxes rectangular as indicated on the Drawings.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, with gasketed cover.

H. Dividers: Provide listed dividers inside multi-gang boxes where required to separate phases.

I. Metal barriers to separate wiring of different systems and voltages exceeding 150V.

J. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

K. Cabinets:
   1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
   1. Exposed Conduit: Rigid steel conduit, IMC, or RNC, Type EPC-40-PVC.
   2. Concealed Conduit, Aboveground: Rigid steel conduit, IMC, or RNC, Type EPC-40-PVC.
   3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
   4. Rising from Underground: Rigid steel
   5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   6. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.

B. Comply with the following indoor applications, unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: Rigid steel conduit, IMC or EMT.
   2. Exposed and Subject to Severe Physical Damage: Rigid steel conduit or IMC. Includes raceways in the following locations:
      a. Loading dock.
      b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
      c. Mechanical rooms.
   3. Concealed in Ceilings and Interior Walls and Partitions: Rigid steel conduit, IMC or EMT.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   5. Damp or Wet Locations: Rigid steel conduit or IMC.
   6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.
   7. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway or EMT. Conduit ends shall be provided plastic bushings.
   8. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: Riser-type, optical fiber/communications cable raceway or EMT. Conduit ends shall be provided plastic bushings.
   9. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: Riser-type, optical fiber/communications cable raceway or Plenum-type, optical fiber/communications cable raceway or EMT. Conduit ends shall be provided plastic bushings. Unless otherwise noted or indicated by the manufacturer's installation instructions, provide rigid steel conduit or IMC for all load-side power feeders, line-side power feeders, or control conduits for variable frequency drives or variable speed drives.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

E. Do not install aluminum conduits in contact with concrete.

F. Do not use spring type conduit clips

G. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

H. Conduits shall be routed inside the building, in lieu of exposed across the roof, unless indicated otherwise.
   1. Roof support for Tray and conduits: Provide a roof support system similar to Cablofil Cablo-Port. The support system shall be
      a. Sunlight, UV and weather resistant and shall use a rubber base in contact with the roof,
      b. Non Penetrating: Fastening system shall not penetrate roof membrane or use glues which are incompatible with the roofing material.
      c. Height and angle adjustable in the field,
      d. Provided with reflective strips,
      e. Composed of recycled materials.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 8 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Install raceways parallel to building lines.

D. Install raceway expansion fittings at building expansion joints and at the addition connection to the existing building, parallel to building lines.

E. Complete raceway installation before starting conductor installation.

F. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

G. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

H. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

I. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

J. Raceways Embedded in Slabs:
   1. Conduits embedded in slabs shall not be larger than 1-inch diameter. Multiple parallel embedded conduits shall be spaced a minimum of 4-inches on center.
   2. Run conduit parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   3. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Provide insulating and grounding bushings at junction boxes, outlet boxes, and cabinets for conduits one-inch and larger in diameter.

M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

N. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

O. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
4. Conduit ends shall be provided plastic bushings.

P. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

Q. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg. F, and that has straight-run length that exceeds 25 feet.
1. Install-expansion joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location.
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125-degree F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155-degree F temperature change.
   c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125-degree F temperature change.
   d. Attics: 135-degree F temperature change.

2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight-run per deg F of temperature change.
3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

R. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
   1. Use LFMC in damp or wet locations.

S. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

T. Set metal floor boxes level and flush with finished floor surface.

U. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
   1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
   2. Install backfill as specified in Division 31 Section "Earth Moving."
   3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
   4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
      a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
      b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
   5. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, placing planks 24 inches o.c. Align planks along the width and along the centerline of conduit.

3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Refer to Specification 26 0500 “Common Work Results for Electrical” for sleeve and sleeve-seal installation instructions.

3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Exception in fire rated wall assemblies: Where the electrical box penetration(s) do not exceed 16sqin, with an aggregate of 100sqin in 100sqft of wall and boxes on opposite sides of the wall are separated by a minimum horizontal distance of 24 inches, fire stopping is not required. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.6 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Coordinate installation of PVC coated conduit with factory authorized representative.
   3. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks and in single duct runs.
   2. Handholes and boxes.

1.3 DEFINITION

A. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Certificates: For concrete and steel used in precast concrete and handholes, as required by ASTM C 858.

B. Qualification Data: For professional engineer and testing agency.

C. Source quality-control test reports.

D. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 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 Construction Manager no fewer than five days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Construction Manager's written permission.

1.8 COORDINATION

A. Coordinate layout and installation of ducts, handholes and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct bank entrances into handholes and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

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. ARNCO Corp.
   2. Beck Manufacturing.
   3. Cantex, Inc.
   4. CertainTeed Corp.; Pipe & Plastics Group.

5. Condux International, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX Inc.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT; a division of Cable Design Technologies.
11. Spiraduct/AFC Cable Systems, Inc.

B. Duct Accessories:
1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."

2.3 PRECAST CONCRETE HANDHOLES AND BOXES

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. Advance Concrete Products Company
2. Carder Concrete Products.
3. Christy Concrete Products.
4. Elmhurst-Chicago Stone Co.
5. Oldcastle Precast Group.
6. Riverton Concrete Product; a division of Cretex Companies, Inc.
7. Utility Concrete Products, LLC.
8. Utility Vault Co.
9. Wausau Tile Inc.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
a. Cover Hinges: Concealed, with hold-open ratchet assembly.
b. Cover Handle: Recessed.

4. Frame and Cover: Weatherproof aluminum frame with hinges aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
   a. Cover Hinges: Concealed, with hold-open ratchet assembly.
   b. Cover handle; Recessed. Coordinate remaining subparagraphs and associated subparagraphs below with Drawings.

5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, ELECTRIC or COMMUNICATIONS.
7. Configuration: Units shall be designed for flush burial and have open or closed bottom, unless otherwise indicated.
8. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
   a. Extension shall provide increased depth of 12 inches.
   b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

9. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
   a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors or frames and cover of handholes, but close enough to corners to facilitate racking of cables on walls.
   b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
   c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

10. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.4 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
   1. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify test by the manufacturer.
   2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

B. Ducts for Electrical Feeders 600 V and Less: RNC**,** NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

D. Underground Ducts for Telephone, Communications, or Data Utility Service Cables; RNC, NEMA Type EPC-40-PVC, installed in direct-buried except ducts for telecommunications (fiberoptic) backbone cables shall be concrete encased duct bank, unless otherwise indicated.

E. Underground Ducts for Telephone, Communications or Data Circuits; RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

F. Underground Ducts Crossing Driveways and Roadways**:** RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.2 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and less Including Telephone, Communications, and Data Wiring:
   1. Units in Roadways and other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
   2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20.
   3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10,
   4. Units subject to Light-Duty Pedestrian Traffic Only: Precast concrete. AASHTO HB 17, H-20 structural load rating.

3.3 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 12.5 feet, both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
   1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
   2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to handhole.
   3. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."

F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

G. Pulling Cord: Install 100-lbf-test nylon cord in ducts, including spares.

H. Concrete-Encased Ducts: Support ducts on duct separators.
   1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
   2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
      a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
      b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
   3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
   4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
   5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
   6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 3-1/2 inches between ducts for like services, and 4 inches between power and signal ducts.
   7. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
   8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
      a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
      b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

9. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

I. Direct-Buried Duct Banks:
   1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
   2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
   3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section “Earth Moving” for pipes less than 6 inches in nominal diameter.
   4. Install backfill as specified in Division 31 Section “Earth Moving”.
   5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31 Section “Earth Moving”.
   6. Install ducts with a minimum of 3-1/2 inches between ducts for like services and 6 inches between power and signal ducts.
   7. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.
   8. Set elevation of bottom of duct bank below the frost line.
   9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
      a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
      b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
   10. Warning Tape: Bury warning tape approximately 12 inches above all direct-buried ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES AND BOXES

A. Precast Concrete Handhole Installation:
   1. Comply with ASTM C 891, unless otherwise indicated.
   2. Install units' level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
   3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:
   1. Install handholes with bottom below frost line. Insert depth of frost line below grade at Project site below grade.
   2. Handhole Covers: In paved areas and trafficways, set surface with finished grade. Set covers of other handholes 1 inch above finished grade.
   3. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

D. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, as required for installation and support of cables and conductors and as indicated.

E. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

F. Field-Installed Bolting Anchors in Concrete Handholes: Do not drill deeper than 3-7/8 inches for 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depth of ducts, and seal joint between box and extension as recommended by manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from ½-inch sieve to NO. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for ducts and conduits, according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving**,** and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
   1. Concrete: 3000 psi,28-day strength, complying with Division 03 Section "Cast-in-Place Concrete" with a troweled finish.
   2. Dimensions: 10 inches wide by 12 inches deep.

3.7 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:
   1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
   2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
   3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes and handholes. Remove foreign material.

END OF SECTION 260543

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
1. Identification for raceway.
2. Identification for conductors and communication and control cable.
3. Underground-line warning tape.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.3 SUBMITTALS

A. Identification List: For each type of electrical identification product indicated, submit labeling concept list to the owner for review.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.145.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

E. When identifying room numbers on labels or directories, coordinate with the Owner's final room numbering system, as the architectural room numbers are generally arbitrary and may not be final.

PART 2 - PRODUCTS

2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Color for Printed Legend:
   1. Power Circuits: Black letters on an orange field.
   2. Legend: Indicate system or service and voltage, if applicable.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

C. Aluminum Wraparound Marker Labels: Cut from 0.014-inch-thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.

D. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking nylon tie fastener.

E. Write-On Tags: Polyester tag, 0.015-inch-thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.

C. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.

D. Warning label and sign shall include, but are not limited to, the following legends:
   1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
   2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
   3. More than 600V Warning: “DANGER – HIGH VOLTAGE – KEEP OUT.”
   4. 480V Warning: “480 VOLTS.”
   5. Phase Color-Coding of 208Y/120V panel boards: “PHASE A - BLACK, PHASE B RED, PHASE C BLUE, NEUTRAL WHITE, GROUND GREEN.”
   6. Phase Color-Coding of 480Y/277V panel boards: “PHASE A - BROWN, PHASE B ORANGE, PHASE C YELLOW, NEUTRAL GRAY, GROUND GREEN.”

2.4 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, 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.
   3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.5 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. Black letters on a white background. Minimum letter height shall be 3/8 inch.

B. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
   1. Minimum Width: 3/16 inch.
   2. Tensile Strength: 50 lb, minimum.
   3. Temperature Range: Minus 40 to plus 185 deg F.
   4. Color: Black, except where used for color-coding.

B. Paint: Paint materials and application requirements are specified in Division 09 painting Sections.
   1. Exterior Concrete, Stucco, and Masonry (Other Than Concrete Unit Masonry):
      a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
         1) Primer: Exterior concrete and masonry primer.
         2) Finish Coats: Exterior semi-gloss acrylic enamel.

   2. Exterior Concrete Unit Masonry:
      a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
         1) Block Filler: Concrete unit masonry block filler.
         2) Finish Coats: Exterior semi-gloss acrylic enamel.

   3. Exterior Ferrous Metal:
      a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
         1) Primer: Exterior ferrous-metal primer.
         2) Finish Coats: Exterior Semi-gloss alkyd enamel.

   4. Exterior Zinc-Coated Metal (except Raceways):
      a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
         1) Primer: Exterior zinc-coated metal primer.
         2) Finish Coats: Exterior Semi-gloss alkyd enamel.

   5. Interior Concrete and Masonry (Other Than Concrete Unit Masonry):
      a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
         1) Primer: Interior concrete and masonry primer.
         2) Finish Coats: Interior Semi-gloss alkyd enamel.

   6. Interior Concrete Unit Masonry:
      a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
         1) Block Filler: Concrete unit masonry block filler.
         2) Finish Coats: Interior Semi-gloss acrylic enamel.

   7. Interior Gypsum Board:
      a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
         1) Primer: Interior gypsum board primer.
         2) Finish Coats: Interior Semi-gloss acrylic enamel.

8. Interior Ferrous Metal:
   a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Interior ferrous-metal primer.
      2) Finish Coats: Interior Semi-gloss acrylic enamel.

9. Interior Zinc-Coated Metal (except Raceways):
   a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
      1) Primer: Interior zinc-coated metal primer.
      2) Finish Coats: Interior Semi-gloss acrylic enamel.

C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

A. Raceways and Duct Banks More Than 600 V Concealed within Buildings: 4-inch-wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces:
   1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
   2. Wall surfaces directly external to raceways concealed within wall.
   3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

B. Accessible Raceways and Metal-Clad Cables More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches high, with snap-around labels or stenciled legend. Repeat legend at 10-foot maximum intervals.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30A: Identify with orange snap-around label or stenciled legend adjacent to each junction box, pull box, and electrical enclosure.

D. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, snap-around, color-coding bands, or stenciled legend:
   1. Fire Alarm System: Red.
   2. Fire-Suppression Supervisory and Control System: Red and yellow.
   3. Combined Fire Alarm and Security System: Red and blue.
   4. Security System: Blue and yellow.
   5. Mechanical and Electrical Supervisory System: Green and blue.
   6. Telecommunication System: Green and yellow.
   7. Control Wiring: Green and red.

E. Power-Circuit Conductor Identification: For primary and secondary conductors No. 4 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape, marker tape, or write-on tags. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

F. Branch-Circuit Conductor Identification: Use marker tape or write-on tags in each junction or pull box. Identify each ungrounded conductor according to source and circuit number.

G. Where more than one source of power enters a piece of equipment, provide a warning label identifying the sources and the disconnect locations. Dual feed warning label (mechanically created)

H. Provide labels at all outlets and junction boxes. Label information to include the source circuit and panel.

I. Identify receptacles with labels on the front and the back of the faceplate. A mechanically created label shall be applied to the front of the faceplate. A permanent marker shall be used on the back of faceplate.

J. Label the outside of all junction and pull boxes cover (inside/outside) with the circuit number and source panel so that all conductors within the box are covered. In an exposed finish application, a mechanically created label is required.

K. Conductors to Be Extended in the Future: Attach write-on tags or marker tape to conductors and list source and circuit number.

L. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
   3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs or metal-backed, butyrate warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
   1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
      a. Power transfer switches.
      b. Controls with external control power connections.
   2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

3. Equipment More Than 600 V: Apply to door or cover of equipment including, but not limited to, the following:
   a. Electrical switchgear.
4. Panel boards rated 208Y/120V or 480Y/277V: Apply phase color-code identification label to door or cover of equipment in including the following:
   a. Panelboards.
   b. Power Panels.
   c. Distribution Panels.
   d. Switchboards.
   e. Motor Control Centers.
5. Equipment Rated 480 V: Unless otherwise indicated, apply to door or cover of equipment. Apply to inside door or cover of flush panelboards and similar equipment in finished spaces.
6. All power distribution equipment: Apply arc flash labels required by code or other sections of the Specification.

N. Instruction Signs:
   1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
   2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.

O. Equipment Identification Labels: All major electrical equipment (i.e. disconnect switches, starters, panelboards, switchboards, transformers, etc.) to be identified with mechanically secured plastic laminated acrylic or melamine labels - White background with black letters. Labels to include unique name, source and system (Normal, Life Safety, Standby Source, etc.). Unique name to match drawings
   1. Labeling Instructions:
      a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where 2 lines of text are required, use labels 2 inches high. For single-gang motor starting switches, use 3/8-inch high letters on 3/4-inch high by 2.25-inch wide label; for two-gang motor starting switches, use 3/8-inch high letters on 3/4-inch high by 4-inch-wide label
      b. Outdoor Equipment: Engraved laminated acrylic, melamine label, or stenciled legend 4 inches high.
      c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
   2. Equipment to Be Labeled:
      a. Panelboards, electrical cabinets, and enclosures.
      b. Access doors and panels for concealed electrical items.
      c. Electrical switchgear and switchboards.
      d. Transformers.
      e. Electrical substations.

f. Emergency system boxes and enclosures.
g. Motor-control centers.
h. Disconnect switches.
i. Enclosed circuit breakers.
j. Motor starters.
k. Push-button stations.
l. Power transfer equipment.
m. Contactors.
n. Remote-controlled switches, dimmer modules, and control devices.
o. Battery inverter units.
p. Battery racks.
q. Power-generating units.
r. Master clock and program equipment.
s. Intercommunication and call system master and staff stations.
t. Fire-alarm control panel and annunciators.
u. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
v. Monitoring and control equipment.
w. Uninterruptible power supply equipment.
x. Terminals, racks, and patch panels for signal and control functions.

P. Electrical Energy Source Identification Labels: On each unit of equipment, install a unique source and circuit designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manuals. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system.
1. Labeling Instructions:
a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 3/8-inch high letters on 3/4-inch high label; where 2 lines of text are required, use labels 1.5 inches high.
b. Outdoor Equipment: Engraved, laminated acrylic or melamine label or stenciled legend.
c. Outlet, Device, Pull and Junction Boxes: Apply source and circuit to back of device box cover and to front of pull and junction box covers with indelible ink.
2. Equipment to be Labeled:
a. Panelboards.
b. Electrical switchgear, switchboards, and distribution panels.
c. Transformers.
d. Electrical substations.
e. Emergency system boxes and enclosures.
f. Motor-control centers.
g. Disconnect switches.
h. Enclosed circuit breakers.
i. Motor starters.
j. Power transfer equipment.

k. Contactors.
l. Central battery inverter units.
m. Power-generating units.
n. Technology (voice and data) equipment racks and cabinets.
o. Master clock and program equipment.
p. Fire alarm control panel and power supplies.
q. Security and intrusion-detection control panels.
r. Uninterruptible power supply equipment.
s. Wiring devices boxes.
t. Junction and pull boxes.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device. Where used on electrical equipment and enclosures also use screws to fasten in place.

E. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. Fasten signs and labels to electrical equipment and enclosures with screws.

G. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
1. Color shall be factory applied or, for sizes larger than No. 6 AWG if authorities having jurisdiction permit, field applied.
2. Colors for 208Y/120-V Circuits Phase A: Black.
   a. Phase B: Red.
   b. Phase C: Blue.
   c. Neutral: White.
   d. Ground: Green.
3. Colors for 480/277-V Circuits:
   a. Phase A: Brown.
   b. Phase B: Orange.
   c. Phase C: Yellow.
   d. Neutral: Gray.
   e. Ground: Green.
4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

I. Painted Identification: Prepare surface and apply paint according to Division 09 painting Sections.

J. Branch and Feeder Circuit Load Identification Labels: On each overcurrent protective device, install unique load designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual.
   1. Labeling Instructions:
      a. Panelboard Circuit Directories: Provide type-written or laser printed circuit directory on heavy card stock. Arrange in two columns with odd numbered circuits on left and even numbered circuits on right. Include panelboard identification and installation date. Indicate spare circuit breakers: "SPARE". Install in metal frame with clear plastic cover. Coordinate with the Owner's final room numbering system.
      b. Overcurrent Protective Devices Installed in Distribution Panels and Switchboards: Engraved, laminated acrylic or melamine labels. Unless otherwise indicated, provide a single line of text with 3/8-inch high letters on 3/4-inch high label; where 2 lines of text are required, use labels 1.5 inches high.

K. Independent Support Wire: Where independent support wires are permissible and utilized for securing electrical raceways, cable assemblies, boxes, cabinets, or fittings within ceiling cavities, they shall be distinguishable from ceiling support wires by color, tagging, or other effective means.

END OF SECTION 260553

SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION AND ARC FLASH HAZARD STUDIES

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 computer-based, fault-current, overcurrent protective device coordination, and arc flash hazard studies.

B. Electrical equipment shall be labeled with the arc flash hazard information based on the results of the arc flash hazard study.

C. As much as possible, the overcurrent protective device settings shall be to keep the arc flash hazard at any point in the system no greater than level 2. Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection and service continuity considered to be of equal importance.

1.3 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Study Report
   1. Submit the fault current study report to the Engineer for review, prior to ordering the electrical distribution equipment.
      a. Provide a tabulation document, as part of the submittal, which compares and identifies discrepancies between, the study results and the proposed electrical distribution equipment.
      b. Highlight designed overcurrent protective devices which have interrupting ratings lower than the
         1) Calculated 1/2-cycle symmetrical fault current or the
         2) Calculated 1/2-cycle asymmetrical fault current, as appropriate.

C. Product Certificates:
   1. For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
   2. For arc flash hazard calculations computer software program certifying compliance with IEEE 1584.

D. Qualification Data: For coordination-study and arc flash specialist.

E. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.
   1. Coordination-study input data, including completed computer program input data sheets.
   2. Study and Equipment Evaluation Reports.
   3. Coordination-Study Report.
   4. Arc flash hazard level report labels as defined in NFPA 70 and NFPA 70E.

F. Electronic Program Files
   1. Provide the Owner with all software program files created for the Overcurrent Protective Device Coordination and Arc Flash Hazard Study at the end of the project, after all revisions and updates have been incorporated. Provide files on CD or flash drive. Files shall include:
      a. One Line Diagrams created with the software.
      b. Short circuit calculations input data and results.
      c. Source data for each power source used in the calculation including but not limited to:
         1) Utilities,
         2) Generators,
         3) Motors,
         4) DC sources.
      d. Overcurrent protective device coordination input data and results including time current curve data for each device used in the calculation.
      e. Protection curve data for each cable, bus, transformer and electric machine used in the calculation
      f. Arc flash hazard study input data and calculation results
      g. Arc flash hazard labels created, for the project, for each piece of equipment.
   2. It shall be assumed that the files provided reflect the calculations of the power distribution system as installed at the point of substantial completion of the project and any power distribution system alterations of the system will require re-evaluation of the system by a qualified engineer.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study and Arc Flash Hazard Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
   1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

E. Comply with IEEE 1584 for arc flash hazard calculations.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:
   1. Paladin Design Base.
   2. ESA Inc.
   3. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots. The program shall generate signage indicating arc flash data that shall be installed on the equipment.
   1. Optional Features:
      a. Arcing faults.
      b. Simultaneous faults.
      c. Explicit negative sequence.
      d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
   1. Proceed with coordination and arc flash hazard studies only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination and arc flash hazard studies:
   1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination and arc flash hazard studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Impedance of utility service entrance.
   3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
      a. Circuit-breaker and fuse-current ratings and types.
      b. Relays and associated power and current transformer ratings and ratios.
      c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
      d. Generator kilovolt amperes, size, voltage, and source impedance.
      e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
      f. Busway ampacity and impedance.
      g. Motor horsepower and code letter designation according to NEMA MG 1.

   4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
      a. Special load considerations, including starting inrush currents and frequent starting and stopping.
      b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
      c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
      d. Generator thermal-damage curve.
      e. Ratings, types, and settings of utility company's overcurrent protective devices.
      f. Special overcurrent protective device settings or types stipulated by utility company.
      g. Time-current-characteristic curves of devices indicated to be coordinated.

h. Manufacturer, frame size, interrupting rating in amperes RMS symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes RMS symmetrical.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in RMS symmetrical amperes at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
1. Distribution panelboard.
2. Branch circuit panelboard.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.
1. Transformers:
a. ANSI C57.12.22.
b. ANSI C57.12.40.
c. IEEE C57.12.00.
d. IEEE C57.96.
2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
3. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:
1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

F. Equipment Evaluation Report:
1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.

3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
   1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
   2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
   3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 241 and IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:
   1. Device shall not operate in response to the following:
      a. Inrush current when first energized.
      b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
      c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
   2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

F. Selective Coordination: Overcurrent protective devices shall coordinate so that the device closest to the fault operates to clear the fault while leaving upstream devices closed. Where this is not possible the engineer shall be notified prior to ordering the power distribution equipment. Practicalities shall be considered, including:
   1. Where selective coordination will cause an increased hazard, discussions with the engineer shall be initiated.
   2. Series devices which will not benefit from selective coordination can be ignored.

G. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
   a. Device tag.
   b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
   c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
   d. Fuse-current rating and type.
   e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that a minimum of 0.1 second separation exists between devices installed in series, including power utility company's upstream devices and generator protection. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
   a. Device tag.
   b. Voltage and current ratio for curves.
   c. Three-phase and single-phase damage points for each transformer.
   d. No damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum fault-current cutoff point.

H. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC FLASH HAZARD CALCULATIONS

A. Perform calculations using an approved computer software program. Prepare signage and install on all equipment as defined by NFPA 70E.
   1. Calculate maximum energy available at each location.
   2. Indicate required PPE equipment level.

B. Comply with IEEE and NFPA 70E.

C. Provide tabular report indicating the following information at each piece of equipment.
   1. Flash Protection Boundary (in inches).
   2. System voltage.
   3. Hazard Risk Category.
   4. Available Fault Current (in kA).
   5. Incident Energy level at 18 inches in CAL/CM^2.
   6. Required PPE level and brief description of PPE.
   7. Shock Hazard Approach Boundaries in inches for Limited, Restricted, and Prohibited.
   8. Equipment ID.
   9. Date.

END OF SECTION 260573

SECTION 262726 - WIRING 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.

1.2 SUMMARY

A. This Section includes the following:
1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Snap switches and wall-box dimmers.
4. Pendant cord-connector devices.
5. Cord and plug sets.
6. Floor service outlets.
7. Poke-through assemblies.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. RFI: Radio-frequency interference.

D. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

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

B. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
   1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

   1. Products: Subject to compliance with requirements, provide:
      a. Hubbell; HBL5351 (single), HBL5352 (duplex).

B. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, provide:
      a. Hubbell; HBL8300SG
   2. Description: Labeled to comply with NFPA 70.

C. USB Combination Receptacle: Provide duplex receptacle as specified above, along with two integral USB charging ports. Each USB port shall be rated 2.1A minimum at 5VDC, and shall be compatible with USB 2.0 & 3.0 devices.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell USB20AC5

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
   1. Subject to compliance with requirements, provide receptacles manufactured by Hubbell.

2.4 TWIST LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, provide the following:

      a. Hubbell; HBL2310

2.5 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R (or as indicated on Drawings), heavy-duty grade.
   1. Subject to compliance with requirements, provide equipment by Hubbell.
   2. Description
      a. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
      b. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.6 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
   1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
   2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.7 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; HBL1221 (single pole), HBL1222 (two pole), HBL1223 (three way), HBL1224 (four way).
   2. Description: Industrial extra heavy-duty specification grade switches.

C. Illuminated Switches, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; HBL1221IL for 120/277V
   2. Description: Single pole, with neon-lighted handle, illuminated when switch is "OFF". Refer to "FINISHES" herein for color.

D. Pilot Light Switches, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; HPL 1221PL for 120 V and 277 V
   2. Description: Single pole, with red neon-lighted handle, illuminated when switch is "ON".

E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; HBL1557

F. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; HBL1557L

2.8 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
   1. 600 W; dimmers shall require no derating when ganged with other devices.
   2. 2000W with trim potentiometer to adjust high-end dimming to a setting between 90 and 100 percent of full brightness, and 5-inch (130-mm) wire connecting leads.

2.9 WALL PLATES

A. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material and color for Finished Spaces: To be selected by the Architect.
   3. Material for Unfinished Spaces: Galvanized steel.
   4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

2.10 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.
   1. Wiring Devices Connected to Normal Power System: To be determined by the Architect, unless otherwise indicated or required by NFPA 70 or device listing.
   2. Wiring Devices Connected to Emergency Power System: Red.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:
   1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
   1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
   2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
   4. Existing Conductors:
      a. Cut back and pigtail, or replace all damaged conductors.

b. Straighten conductors that remain and remove corrosion and foreign matter.
c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:
1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
1. Install receptacles horizontally mounted ground pin to the left.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:
1. Install dimmers within terms of their listing.
2. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices:
1. Unless otherwise indicated, mount flush, with switch long dimension vertical. Group adjacent switches under single, multi-gang wall plates.
2. ALIGN DEVICES IN THE SAME STUD SPACE IN THE SAME VERTICAL LINE.

I. Adjust locations of floor service outlets to suit arrangement of partitions and furnishings.

J. Provide Tamper-Resistant type receptacles in all "Child Care Facilities" and "Dwelling Units" as defined and required by NFPA 70.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."
   1. Receptacles and switches: Identify panelboard and circuit number from which served. Use durable wire marker on the back (inside) of the cover plate.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Test Instruments: Use instruments that comply with UL 1436.
   2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value above five percent is not acceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 262726

SECTION 262813 - FUSES

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. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches and panelboards, switchboards and enclosed controllers, and motor-control centers.

1.3 SUBMITTALS

A. Operation and Maintenance Data: For fuses 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. Ambient temperature adjustment information.
   2. Current-limitation curves for fuses with current-limiting characteristics.
   3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
   4. Coordination charts and tables and related data.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from 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. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer’s ambient temperature adjustment factor to fuse ratings.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.7 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Bussmann, Inc.
   2. Ferraz Shawmut, Inc.
   3. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:
   1. Feeders: Class L, time delay for feeders over 600 amps, Class RK1, time delay for smaller feeders.
   2. Motor Branch Circuits: Class RK1, time delay.
   3. Other Branch Circuits: Class RK1, time delay.
   4. Control Circuits: Class CC, time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Enclosures.

1.3 PERFORMANCE REQUIREMENTS

A. Field quality-control reports.
1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

B. Operation and Maintenance Data: For enclosed switches 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 enclosed switches.
2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches, overcurrent protective devices, components, and accessories, within same product category, from single source from 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. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

A. conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
   2. Altitude: Not exceeding 6600 feet.

1.6 COORDINATION

A. Coordinate layout and installation of switches and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.7 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240-V or 600-V ac as required, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three 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: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   4. Auxiliary contact, rated 125V, 20A, which opens and closes with the main disconnect contacts.
   5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 ENCLOSURES

A. Enclosed Switches: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.
   3. Kitchen or Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
   4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
   5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install individual wall-mounted switches with tops at uniform height unless otherwise indicated.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. Comply with NECA 1.

E. Provide service disconnect switches at all motors so that the condition/status of the switch and motor are easily discernible from either location.

F. Place switches so that the operator may be able to stand to the side of the switch during operation.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262816

SECTION 262913 - ENCLOSED CONTROLLERS

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 ac, enclosed controllers rated 600 V and less, of the following types:
   1. Across-the-line, manual and magnetic controllers.
   2. Multispeed controllers.

1.3 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each enclosed controller.
   1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Each installed unit's type and details.
      b. Nameplate legends.
      c. Short-circuit current rating of integrated unit.
      d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.

   2. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For enclosed controllers 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. Routine maintenance requirements for enclosed controllers and all installed components.

F. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.6 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

D. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

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. Spare Fuses: Furnish one spare for every ten installed, but no fewer than one set of three of each type and rating.
   2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Square D.

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."
   1. The external operating mechanism shall be provided, from the factory, with the capability of locking the electrical contacts in the open position. The locking mechanism shall be key operated.
   2. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.
   1. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
   2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 20 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
   3. Minimum controller size shall be NEMA size 1.

C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.
   1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.

2.3 MULTISPEED ENCLOSED CONTROLLERS

A. Multispeed Enclosed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:
   1. Compelling relay to ensure that motor will start only at low speed.
   2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
   3. Decelerating relay to ensure automatically timed deceleration through each speed.

2.4 ENCLOSURES

A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
   1. Outdoor Locations: NEMA 250, Type 3R.
   2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
   3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
   4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7**C**.

2.5 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.

2.6 FACTORY FINISHES

A. Finish: Manufacturer's standard gray paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

C. Furnish and install phase-failure and undervoltage relays for all combination magnetic controllers controlling motors five horsepower or larger.

3.3 INSTALLATION

A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Install freestanding equipment on concrete bases.

C. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

3.4 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. 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.

3.5 IDENTIFICATION

A. Identify enclosed controller, components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.6 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
   2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.7 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS, "Motor Control - Motor Starters." Certify compliance with test parameters.
      a. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
      b. Test continuity of each circuit.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.9 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 262913

SECTION 269999 - ELECTRICAL TESTING

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 work of this section.

B. Division 01, Commissioning Requirements, applies to this section and will require the contractor participation in the commissioning process.

C. Division 01 Section “LEED Requirements.”

D. Specification sections indicating testing requirements for electrical systems or equipment.

1.2 SUMMARY

A. This Section includes testing general administrative and procedural requirements for electrical testing. Provide specific testing of electrical equipment devices, installations, and systems, as indicated in the Specifications and Drawings.

1.3 QUALIFICATIONS

A. The testing firm shall be a corporately independent testing organization, which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.

B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

C. The lead, on site, technical person shall be currently certified by the InterNational Electrical Testing Association (NETA) or the National Institute for Certification in Engineering Technologies (NICET) in Electrical Power Testing.

D. The testing firm shall only utilize full time technicians with the firm providing the testing services.

E. The Contractor shall submit proof of the above qualifications with bid proposal.

F. Acceptable Testing Firms:
   1. Northern Electrical Testing
   2. Utilities Instrumentation Services

1.4 PERFORMANCE REQUIREMENTS

A. The Electrical Contractor shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the power requirements.

B. The Electrical Contractor shall notify the testing firm when equipment becomes available for acceptance tests.
   1. Work shall be coordinated to safely expedite project scheduling.
   2. The testing firm shall notify the Owner's Representative, in writing, prior to commencement of any testing.

C. Any system, material or workmanship, which is found defective on the basis of acceptance tests, shall be reported to the Architect/Engineer. The Electrical Contractor shall correct all defects.

D. The testing organization shall maintain a written record of all tests and shall assemble and certify a final test report.

E. Safety and Precautions

   1. Safety practices shall include, but are not limited to, the following requirements:
      a. Occupational Safety and Health Act.
      b. Accident Prevention Manual for Industrial Operations, National Safety Council.
      c. Applicable state and local safety operating procedures.
      d. NETA Safety/Accident Prevention Program.
      e. Owner's safety practices.
      f. National Fire Protection Association - NFPA 70E.
      g. American National Standards for Personnel Protection.

   2. All tests shall be performed with apparatus de-energized except where otherwise specifically required.

   3. The testing organization shall have a designated safety representative on the project to supervise operations with respect to safety.

1.5 TEST INSTRUMENT CALIBRATION

A. Test Instrument Calibration
   1. The testing firm shall have a calibration program, which assures that all applicable test instruments are maintained within rated accuracy, meeting standards set by the National Institute of Standards and Technology (NIST).

   2. Dated calibration labels shall be visible on all test equipment.
   3. Maintain current records which show;
      a. Dated results of instruments' calibration and test procedures.
      b. Instrument calibration instructions and procedures for each test instrument.

B. Suitability of Test Equipment
   1. All test equipment shall be in good mechanical and electrical condition to promote a safe working environment.
   2. Metering equipment shall be suitable for the test being performed and be compatible with the electrical characteristics of the system under test.
   3. Use of RMS measuring meters is recommended.
   4. The accuracy of the field test metering equipment, used to check the calibration of the power system meter, shall be higher than that of the instrument being checked.
   5. Accuracy of metering in test equipment shall be appropriate for the test being performed.

1.6 TEST REPORTS

A. A test report shall be generated for each piece of electrical equipment, device, installation, and system, as indicated in the Specifications and Drawings and shall include the following:
   1. Check list of visual and mechanical inspections.
   2. Test reports, including test values where applicable, for all required electrical tests.
   3. Obvious indication, on the first page of the test report, where test results fall outside of the limits of recommended values.
   4. Summary and interpretation of test results:
      a. Describe the problem in detail,
      b. Offer suggestions for solutions and correction.
   5. Signed and dated by the testing firm field superintendent stating that all required tests have been completed.

B. Test reports shall be furnished to the Architect/Engineer within 14 days of the completion each test on an ongoing basis. Original copies of the reports shall be furnished directly to the Architect/Engineer by the testing company prior to formal submittal via the Contractors.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 THERMOGRAPHIC SURVEY

A. Visual and Mechanical Inspection
   1. Remove all necessary covers prior to scanning.
   2. Inspect for physical, electrical, and mechanical condition.

B. Equipment to be Scanned
   1. All components of the distribution system down to and including branch circuit panelboards and motor control centers. Return 3 months after equipment has been energized and loaded to do a final scan of all equipment.
   2. Coordinate the timing of the visit with the Owner's representative to perform the testing during peak operating hours.

C. Provide report indicating the following:
   1. Problem area (location of "hot spot").
   2. Temperature rise between "hot spot" and normal or reference area.
   3. Cause of heat rise.
   4. Phase unbalance, if present.
   5. Areas scanned.

D. Test Parameters
   1. Scanning distribution system with ability to detect 1°C between subject area and reference at 30°C.
   2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
   3. Perform infrared surveys during periods of maximum possible loading,
   4. Identify areas under test which are loaded to less than twenty percent (20%) of rated capacity.

E. Test Results

   1. Identify temperature gradient issues per NETA standards. Identify where gradients fall into the following ranges:
      a. Temperature gradients of 3°C to 7°C indicate possible deficiency and warrant investigation.
      b. Temperature gradients of 7°C to 15°C indicate deficiency; repair as time permits.
      c. Temperature gradients of 16°C and above indicate major deficiency; repair immediately.

END OF SECTION 269999

THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK

WE RECYCLE

RENOVATIONS FOR:

LANSING SCHOOL DISTRICT

LYONS ELEMENTARY SCHOOL MECHANICAL IMPROVEMENTS

2901 LYONS AVE., LANSING, MI 48910

PROJECT NUMBER: 22-0179

LANSING SCHOOL DISTRICT BOND: SB-0051

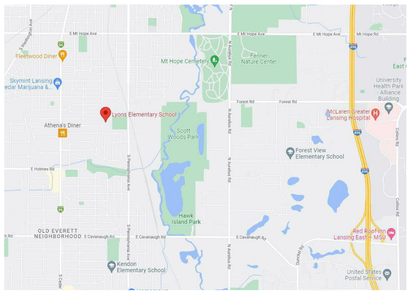
ISSUE DATE: 11-NOV-2022

CONSTRUCTION DOCUMENTS

N W E S

LOCATION MAP

NO SCALE



N W E S

VICINITY MAP

NO SCALE

Know what's **below.**
Call before you dig.

IT IS UNDERSTOOD THAT THE CONTRACTOR SHALL PERFORM ALL WORK UNDER THIS CONTRACT IN ACCORDANCE WITH ALL APPLICABLE PROVISIONS, POLICIES, RULES AND STANDARDS OF THE MICHIGAN OCCUPATIONAL SAFETY AND HEALTH ACT (MDSHA), BEING ACT 154 OF THE PUBLIC ACTS OF 2013 AND AS AMENDED.

EXCEPT WHERE OTHERWISE INDICATED ON THE PLANS OR IN THE PROPOSAL SUPPLEMENTAL SPECIFICATIONS CONTAINED THEREIN, ALL MATERIALS AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE APPLICABLE SECTIONS OF THE MICHIGAN DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR CONSTRUCTION, 2012 EDITION, AND THE CURRENT SUPPLEMENTAL SPECIFICATIONS. (AVAILABLE AT WWW.MDOTJBOSS.STATE.MI.US/SPECPROV/SPECBOOKHOME.HTM#1468271)

THROUGHOUT THE DRAWING SET, THE GRAYSCALE LEGEND ON THE EDGE OF TITLE BLOCKS SHOULD TRANSITION FROM WHITE THROUGH EIGHT SHADES OF GRAY TO SOLID BLACK. IF THE GRAYSCALE SHADES ARE NOT DISTIINCT, THE DRAWING(S) HAVE NOT PRINTED CORRECTLY.

Lansing© School District

SHEET NO.	SHEET NAME
GENERAL	
G-001	COVER SHEET
ARCHITECTURAL	
A-001	ARCHITECTURAL LEGENDS, SYMBOLS, AND ABBREVIATIONS
A-002	STRUCTURAL DETAILS
AD101	DEMOLITION PLAN
A-101	FLOOR PLAN
A-102	ROOF PLAN
A-201	EXTERIOR ELEVATIONS
A-401	INTERIOR ELEVATIONS
MECHANICAL	
M-001	MECHANICAL LEGEND, SYMBOLS, AND ABBREVIATIONS
MD100	MECHANICAL DEMOLITION PLAN - TUNNEL LEVEL
MD101	MECHANICAL DEMOLITION PLAN - FIRST LEVEL
M-100	MECHANICAL PLAN - TUNNEL LEVEL
M-101	MECHANICAL PLAN - FIRST LEVEL
M-102	MECHANICAL PLAN - ROOF LEVEL
M-501	MECHANICAL DETAILS
M-601	MECHANICAL SCHEDULES
M-602	MECHANICAL SCHEDULES
M-701	TEMPERATURE CONTROLS LEGEND AND DIAGRAMS
ELECTRICAL	
E-001	ELECTRICAL SYMBOLS AND ABBREVIATIONS
E-002	ELECTRICAL SYMBOLS AND ABBREVIATIONS
ED-111	FIRST LEVEL ELECTRICAL DEMOLITION PLAN
E-211	FIRST LEVEL POWER & AUXILIARY PLAN
E-212	ROOF LEVEL POWER & AUXILIARY PLAN
E-401	ELECTRICAL SINGLE LINE DIAGRAM
E-501	ELECTRICAL DETAILS
TOTAL SHEETS: 25	

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Stantec

LANSING SCHOOL DISTRICT
LYONS ELEMENTARY SCHOOL MECHANICAL IMPROVEMENTS
2901 LYONS AVE., LANSING, MI 48910

COVER SHEET

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0179

DATE: 11-NOV-2022

SHEET

G-001

CONSTRUCTION DOCUMENTS

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DESIGNED BY: Designer
CHECKED BY: Checker APPROVED BY: Approver

WE RECYCLE

THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID

BLACK

WHITE

ABBREVIATIONS

ABBREV.	FULL TEXT
AB	ANCHOR BOLT
ABI	ADDITIVE BID ITEM
AC	ACOUSTICAL
ACB	ACOUSTICAL CEILING BAFFLE
ACP	ACOUSTICAL CEILING PANEL
ACS	ACOUSTICAL CEILING SPRAY
AD	AREA DRAIN
ADA	ADA
AFF	ABOVE FINISHED FLOOR
AL	ALUMINUM
ALUM	ALUMINUM
AP	ACCESS DOORS
APPROX	APPROXIMATE
ARCH	ARCHITECTURAL
ASPH	ASPHALT
AWP	ACOUSTICAL WALL PANEL
B/	BOTTOM OF
BD	BOARD
BF	BARRIER FREE
BIT	BITUMINOUS
BL	BUILDING LINE
BLDG	BUILDING
BLKHD	BULKHEAD
BOTT	BOTTOM
BP	BASE PLATE
BR	BUMP RAIL
BS	BOTH SIDES
BUR	BUILT UP ROOFING
CAB	CABINET
CB	CATCH BASIN
CEM	CEMENT
CG	CORNER GUARD
CH	CHANNEL
CHKDPL	CHECKERED PLATE
CJ	CONTROL JOINT
CL	CENTERLINE
CL TO CL	CENTERLINE TO CENTERLINE
CLG	CEILING
CLK	CAULKING
CLR	CLEAR
CMU	CONCRETE MASONRY UNIT
CO	CLEAN OUT
COL	COLUMN
COMP	COMPRESSIBLE
COMPO	COMPOSITION
CONC	CONCRETE
CONN	CONNECT, CONNECTION
CONST	CONSTRUCTION
CONST JT	CONSTRUCTION JOINT
CONT	CONTINUOUS
CONTR	CONTRACTOR
CPT	CARPET TILE
CS	CONCRETE SEALER
CTR	COUNTER
CTSK	COUNTERSINK
DEXS	DOUBLE EXTRA STRONG (STEEL PIPE)
DF	DRINKING FOUNTAIN
DIA	DIAMETER
DIFF	DIFFUSER
DN	DOWN
DO	DOOR OPENING
DR	DOOR
DS	DOWN SPOUT
DT	DRAIN TILE
DTL	DETAIL
DWG	DRAWING
DWR	DRAWER
E	EAST
EA	EACH
EIFS	EXTERIOR INSULATION AND FINISH SYSTEMS
EJ	EXPANSION JOINT
EL	ELEVATION
ELECT	ELECTRICAL
ELEV	ELEVATOR OR ELEVATION
ENCL	ENCLOSURE
EP	EPOXY PAINT
EPS	EXTERIOR PAINT SYSTEM
EQ	EQUAL
EQUIP	EQUIPMENT
ES	EXPOSED STRUCTURE
EW	EACH WAY
EWC	ELECTRICAL WATER COOLER
EX	EXISTING

ABBREVIATIONS

ABBREV.	FULL TEXT
EXGR	EXISTING GRADE
EXP	EXPANSION
EXS	EXTRA STRONG (STEEL PIPE)
EXT	EXTERIOR
FA	FIRE ALARM
FAB	FABRIC/UPHOLSTERY
FD	FLOOR DRAIN
FDN	FOUNDATION
FE	FIRE EXTINGUISHER
FEC	FIRE EXTINGUISHER CABINET
FG	FROSTED GLASS
FHC	FIRE HOSE CABINET
FIN	FINISH
FL	FLOOR
FLL	FLOOR LINE
FLUOR	FLUORESCENT
FOC	FACE OF COLUMN
FOCONC	FACE OF CONCRETE
FRC	FIBER REINFORCED CONCRETE
FRP	FIELD REINFORCED PANEL
FRPFG	FIREPROOFING
FS	FULL SIZE
FT	FIRE TREATED
FTG	FOOTING
FUR	FURRING
FV	FIELD VERIFY
G.B.	GRAB BAR, GRADE BEAM
G.O.	GRILL OPENING
GA	GAUGE
GALV	GALVANIZED
GCT	GLAZED CERAMIC TILE
GFCI	GROUND FAULT CIRCUIT INTERRUPTER
GL	GLASS
GND.	GROUND
GR.	GRADE
GRTG.	GRATING
GSCFT	GLAZED STRUCTURAL CLAY FACING TILE
GT	GROUT
GYP. BD.	GYPSUM BOARD
HC	HOLLOW CORE
HCWD	HOLLOW CORE WOOD
HDPB	HIGH DENSITY PARTICLEBOARD
HM	HOLLOW METAL
HORIZ	HORIZONTAL
HP	HIGH POINT
HR	HOUR
HT	HEIGHT
HWD	HARDWARE
I.D. OR ID	INSIDE DIAMETER
I.E.	INVERT ELEVATION
IG	INSULATING GLASS
IN	INCHES
INCL	INCLUDING, INCLUSIVE
INSUL	INSULATION
INT	INTERIOR
IPS	INTERIOR PAINT SYSTEM
JAN	JANITOR
JT	JOINT
kW	KILOWATTS
kWh	KILOWATT HOURS
LAD	LADDER
LAM	LAMINATED
LAV	LAVATORY
LF	LINEAR FEET
LGTH	LENGTH
LH	LEFT HAND
LKR	LOCKER
LLH	LONG LEG HORIZONTAL
LLV	LONG LEG VERTICAL
LO	LOUVER OPENING
LP	LIGHTING PANEL
LPG	LIQUID PETROLEUM GAS
LPS	LOW PRESSURE STEAM
LT	LIGHT
LWT	LEAVING WATER TEMPERATURE
MA	MEDICAL AIR
MANUF	MANUFACTURER
MAS	MASONRY
MATL	MATERIAL
MAX	MAXIMUM
MBH	THOUSAND BTU/HR
MC	MEDICINE CABINET
MCA	MINIMUM CIRCUIT AMPACITY
MCC	MULTI-COLOR COATING

ABBREVIATIONS

ABBREV.	FULL TEXT
MDO	MEDIUM DENSITY OVERLAY
MECH	MECHANICAL
MEMBWP	MEMBRANE WATERPROOFING
MET	METAL
MEZZ	MEZZANINE
MFR	MANUFACTURER
MFS	MAXIMUM FUSE SIZE
MG	MEDICAL GAS
MH	MANHOLE
MHP	MOTOR HORSEPOWER
MIN.	MINIMUM
MIRR	MIRROR
MISC	MISCELLANEOUS
MM	MISCELLANEOUS METALS
MO	MASONRY OPENING
MOCP	MAXIMUM OVERCRRENT PROTECTION
MPC	MICHIGAN PLUMBING CODE
MR	MANUFACTURER'S RECOMMENDATIONS
MT	MARBLE TILE
MTD	MOUNTED
MUL.	MULLION
N	NORTH
N.S.	NEAR SIDE
NF	NO FINISH
NIC	NOT IN CONTRACT
NO	NUMBER
NPSH	NET POSITIVE SUCTION HEAD
NSNS	NON SHRINK NON STAIN GROUT
NTS	NOT TO SCALE
NTS	NOT TO SCALE
O.C. OR OC	ON CENTER
OBSGL	OBSCURE GLASS
OD	OUTSIDE DIAMETER
OHDR	SECTIONAL OVERHEAD DOOR
OPNG	OPENING
OPP	OPPOSITE
P	PAINT
PART	PARTITION
PB	PARTICLE BOARD
PC	PRECAST
PCS	PIECES
PERM	PERMANENT
PL	PLATE
PLAM	PLASTIC LAMINATE
PLAS	PLASTER
PLBG	PLUMBING
PLY	PLYWOOD
PT	PRESSURE TREATED
PT	PORCELAIN TILE
PTB	PORCELAIN TILE BASE
QT	QUARRY TILE
QTB	QUARTZ TILE BASE
QTZ	QUARTZ
R	RISER
RA	RETURN AIR
RB	RUBBER BASE
RC	ROOF CONDUCTOR
RD	ROOF DRAIN
RD	ROUND
RECVG	RECEIVING
REF	REFRIGERATOR
REINF	REINFORCED
REQ'D	REQUIRED
RF	RESILIENT FLOORING
RH	RIGHT HAND
RL	ROOF LADDER
RM	ROOM
RO	ROUGH OPENING
RS	ROOF SUMP
RSN	RESIN
RWD	REDWOOD
RWD	RIGID WALL PROTECTION
S	SOUTH
S	SPANDREL GLASS
SA	SUPPLY AIR
SAB	SOUND ATTENUATION BLANKETS
SC	SOLID CORE
SCH	SCHEDULE
SCONC	SEALED CONCRETE
SCWD	SOLID CORE WOOD
SECT	SECTION
SER.RECPT	SERVICE RECEPTOR
SH	SHELF
SHT	SHEET

ABBREVIATIONS

ABBREV.	FULL TEXT
SHWR	SHOWER
SIM	SIMILAR
SLR	CONCRETE SEALER
SLS	SOLID SURFACE
SLV	SHORT LEG VERTICAL
SPEC	SPECIFICATION
SQ	SQUARE
SQFT	SQUARE FOOT
SS	STAINLESS STEEL
SSK	SERVICE SINK
SSM	SOLID SURFACING MATERIAL
ST	SMOKE-TIGHT PER CODE TO RESIST THE PASSAGE OF SMOKE
STD	STANDARD
STDW	STANDARD WEIGHT (STEEL PIPE)
STL	STEEL
STN	STAIN
STOR	STORAGE
STRL	STRUCTURAL
SUPP	SUPPORT
SUSP	SUSPENDED
SYM	SUSPENSION SYMMETRICAL
T	TREAD
T&G	TONGUE AND GROOVE
T.O.C. OR T/C	TOP OF CONCRETE
T.O.F. OR T/F	TOP OF FOOTING
T.O.M. OR T/M	TOP OF MASONRY
T.O.P. OR T/P	TOP OF PAVEMENT
T.O.S. OR T/S	TOP OF STEEL
T.O.W. OR T/W	TOP OF WALL
T/	TOP OF
TB	TRUSS BEARING
TG	TEMPERED GLASS
THK	THICK
THRESH	THRESHOLD
TLT	TOILET
TP	TOILET PARTITION
TR	TRANSITION TRIM
TYP	TYPICAL
TYP	TYPICAL
UNF	UNFINISHED
UNO	UNLESS NOTED OTHERWISE
UR	URINAL
VCT	VINYL COMPOSITION TILE
VERT	VERTICAL
VEST	VESTIBULE
VIF	VERIFY IN FIELD
W	WEST
W/	WITH
W/O	WITHOUT
WC	WATER CLOSET
WC	WALLCOVERING
WCO	WALL CLEAN OUT
WCVR	WALLCOVERING
WD	WOOD
WP	WATERPROOFING
WP	WORKPOINT
WP	WALL PROTECTION
WS	WINDOW SHADE
WSCT	WAINSCOT
WT	WEIGHT
X-(MATERIAL)	DENOTES EXISTING MATERIAL REFRENCED

DRAWING REFERENCE SYMBOLS

ENLARGED PLAN OR DETAIL

WALL SECTION

BUILDING SECTION

EXTERIOR ELEVATIONS

INTERIOR ELEVATIONS

REVISION CLOUD AND TAG

VIEW TITLE & REFERENCE

DETAIL

EXISTING COLUMN LINE

NEW COLUMN LINE

DEMO KEYNOTE

LEVEL OR ELEVATION

DEMARCATION LINE

ARCHITECTURAL KEYNOTE

X## EQUIPMENT TAG

X# WALL TAG

###.# DOOR TAG

ROOM NAME ### ROOM TAG

WINDOW TAG

#' - #" CEILING SPOT ELEVATION

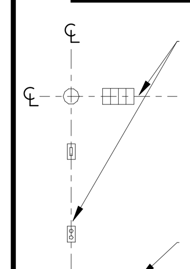
XX-# FINISH TAG

XX- # SPECIALITY EQUIPMENT TAG

XX# FURNITURE TAG

RECOMMENDED MOUNTING HEIGHTS (UNLESS OTHERWISE NOTED)

MOUNTING HEIGHT COORDINATION

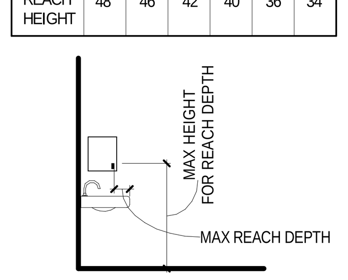


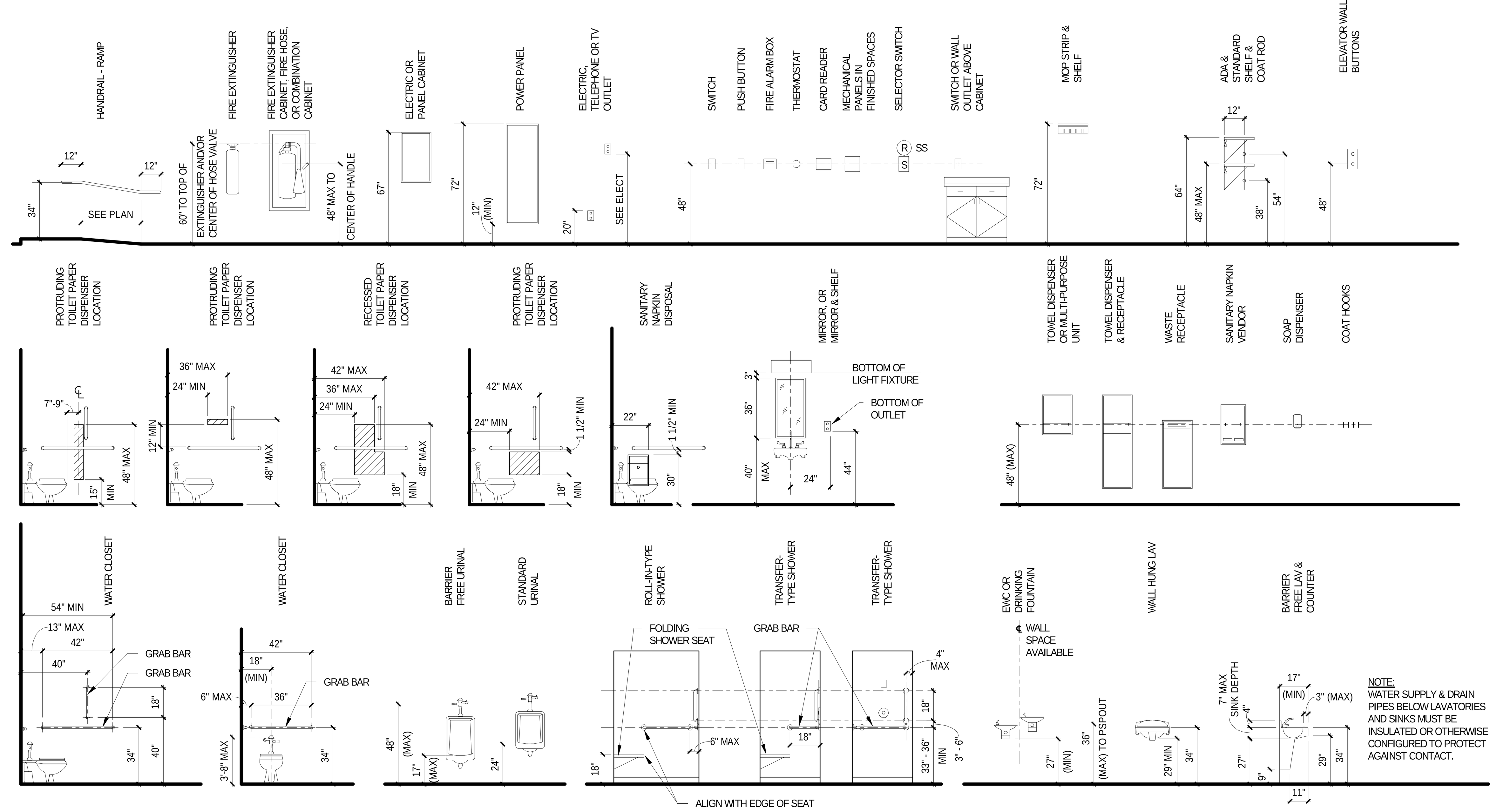
ARCHITECTURAL, MECHANICAL & ELECTRICAL TRADES SHALL COORDINATE LOCATIONS OF WALL MOUNTED ITEMS TO ALIGN EITHER VERTICALLY OR HORIZONTALLY.

FINISH FLOOR LINE

GENERAL MAXIMUM REACH DEPTH AND HEIGHT FOR HAND DRYERS / TOWEL DISPENSERS

MAX REACH DEPTH	0.5"	2"	5"	6"	9"	11"
MAX REACH HEIGHT	48"	46"	42"	40"	36"	34"





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ARCHITECTURAL LEGENDS, SYMBOLS, AND ABBREVIATIONS

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0179

DATE: 11-NOV-2022

SHEET

A-001

CONSTRUCTION DOCUMENTS

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DESIGNED BY: Designer

CHECKED BY: Checker APPROVED BY: Approver

THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK
WHITE
WE RECYCLE

GENERAL STRUCTURAL NOTES

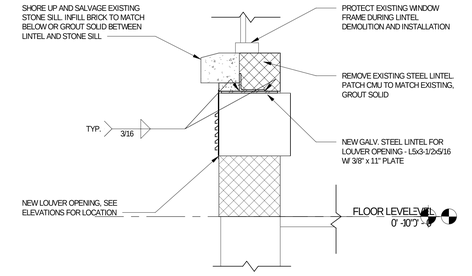
1. IT IS THE CONTRACTOR'S RESPONSIBILITY TO VERIFY ALL DIMENSIONS AND CONDITIONS AT THE JOB SITE AND TO CROSS-CHECK DETAILS AND DIMENSIONS ON THE STRUCTURAL DRAWINGS WITH THE RELATED REQUIREMENTS ON THE ARCHITECTURAL, MECHANICAL, ELECTRICAL, AND PLUMBING PLANS. FLOOR AND WALL OPENINGS, SLEEVES AND OTHER ARCH., MECH., ELEC., REQUIREMENTS MUST BE COORDINATED BEFORE THE CONTRACTOR PROCEEDS WITH CONSTRUCTION.
2. ALL ENGINEERING DESIGN, CONSTRUCTION, AND TESTING SHALL CONFORM TO THE REQUIREMENTS OF THE MOST RECENT EDITION OF THE MICHIGAN BUILDING CODE.
3. ALL STRUCTURAL WORK MUST BE TEMPORARILY BRACED AND SUPPORTED UNTIL THE STRUCTURE IS SUFFICIENTLY COMPLETED AND CAN SAFELY CARRY THE DESIGN AND CONSTRUCTION LOADS.
4. ALL OMISSIONS OR CONFLICTS BETWEEN THE VARIOUS ELEMENTS OF THE WORKING DRAWINGS AND/OR SPECIFICATIONS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER BEFORE PROCEEDING WITH ANY WORK THAT IS INVOLVED IN THE CONFLICT.

STRUCTURAL DESIGN INFORMATION:
DESIGN DATA BASED ON ASCE 7-16
RISK CATEGORY III

1. SNOW LOAD:
   - SNOW EXPOSURE FACTOR (Ce) 1.0
   - THERMAL FACTOR (Ct) 1.0
   - SNOW IMPORTANCE FACTOR (Is) 1.1
   - GROUND SNOW LOAD (Pg) 30 PSF
   - FLAT ROOF SNOW LOAD (Pf) 23.1 PSF
2. LIVE LOAD:
   - CONSTRUCTION 25 PSF
3. WIND LOADS:
   - BASIC WIND SPEED 114 MPH
   - WIND IMPORTANCE FACTOR (Iw) 1.00
   - WIND EXPOSURE CATEGORY 'B'
5. SEISMIC LOADS:
   - SEISMIC IMPORTANCE FACTOR (Ie) 1.25
   - SITE CLASS 'D'
   - SEISMIC DESIGN CATEGORY 'B'

STRUCTURAL STEEL:

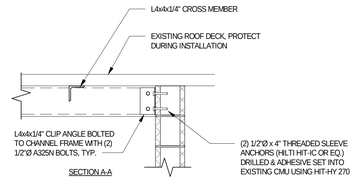
1. MATERIAL STANDARDS:
   ANGLE, CHANNELS, PLATES ASTM A36 Fy = 36,000 PSI
2. STRUCTURAL AND MISC. STEEL SHALL BE DETAILED, FABRICATED AND ERECTED IN ACCORDANCE WITH THE MOST RECENT EDITION OF AISC STEEL CONSTRUCTION MANUAL AND CODE OF STANDARD PRACTICE.
3. WELDING SHALL BE DONE IN ACCORDANCE WITH THE "AMERICAN WELDING SOCIETY" (AWS) D1.1, USING E70 ELECTRODES. WELDING SHALL BE PERFORMED BY AN APPROVED CERTIFIED WELDER.
4. NO CHANGES SHALL BE MADE IN THE STEEL STRUCTURE NOR ANY MATERIAL CUT IN THE FIELD (UNLESS NOTED AS 'FIELD CUT OR TRIM' ON DRAWINGS), WITHOUT THE WRITTEN PERMISSION OF THE ENGINEER.
5. NO CUTTING, BURNING, OR HOLES OTHER THAN THOSE SPECIFICALLY DETAILED SHALL BE ALLOWED THROUGH STRUCTURAL STEEL MEMBERS WITHOUT THE PRIOR CONSENT OF THE ENGINEER. BOLT HOLES SHALL CONFORM WITH THE GOVERNING AISC SPECIFICATION, AND SHALL BE STANDARD HOLES UNLESS NOTED OTHERWISE.
6. THE ENGINEER SHALL BE NOTIFIED IMMEDIATELY OF ANY DISCREPANCIES BETWEEN THE DESIGN AND ACTUAL CONDITIONS NOTED IN THE FIELD.
7. CONTRACTOR SHALL PROVIDE NECESSARY LABOR, MATERIAL, AND EQUIPMENT TO ERECT ALL MISCELLANEOUS IRON AND STEEL AS DETAILED ON THESE DRAWINGS.
8. THE CONTRACTOR SHALL FIELD VERIFY ALL DIMENSIONS PRIOR TO FABRICATION.
6. ALL MATERIALS SHALL RECEIVE ONE SHOP COAT OF GRAY STANDARD RUST INHIBITIVE STEEL PRIMER. ALL WELDS, ABRASIONS, AND OTHER SURFACE DEFECTS IN THE SHOP PRIMER SHALL RECEIVE ONE FIELD APPLIED COAT OF RUST INHIBITIVE PRIMER, PRIOR TO ENCLOSURE OR FINAL ACCEPTANCE. PAINT SHALL NOT BE APPLIED TO THOSE MEMBERS WHICH ARE TO BE FIREPROOFED.

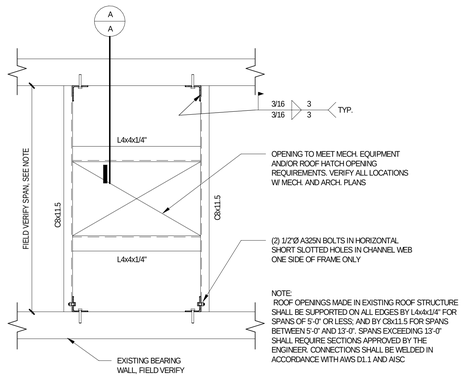


NOTES:

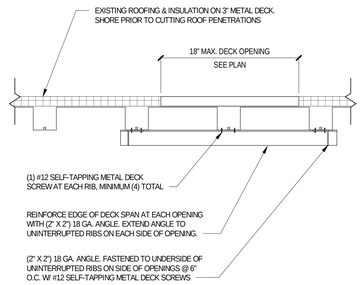
1. THE LINTEL SIZE SHOWN IN THIS DETAIL IS FOR OPENINGS LESS THAN 7'-0". NOTIFY ENGINEER IF LARGER OPENINGS ARE REQUIRED.
2. LINTELS SHALL BEAR A MINIMUM OF 8" ON FULLY GROUTED COURSES OF SOLID MASONRY BEYOND CLEAR OPENING SIZES.
3. ALL LINTELS AT EXTERIOR LOCATIONS OR OTHERWISE SUBJECT TO WEATHER OR CORROSIVE ATMOSPHERE SHALL BE GALVANIZED. LINTELS CONSISTING OF A PLATE AND PAIR OF ANGLES SHALL HAVE BOTH PLATE AND ANGLES GALVANIZED AFTER WELDING. ALL ANGLES SHALL BE GALVANIZED.
4. LINTELS UTILIZING BOTTOM PLATES SHALL HAVE PLATE EXTEND FULL LENGTH OF MASONRY OPENING ONLY. BOTTOM PLATES SHALL NOT EXTEND INTO JAMBS OF WALL OPENINGS.
5. FOR OPENINGS 16 INCHES AND SMALLER, PROVIDE SOLID GROUTED BOND BEAM WITH (2) #5 BARS WITH 8" MIN. BEARING EACH SIDE OF OPENING.
6. THE LINTEL SIZE SHOWN IN THIS DETAIL IS FOR SINGLE STORY WALLS ONLY.

2 LINTEL FOR LOUVER BELOW EXISTING WINDOW
1" = 1'-0"





1 FRAMING @ ROOF OPENING
NOT TO SCALE



3 TYPICAL DECK REINFORCEMENT AT ROOF PENETRATION
1 1/2" = 1'-0"

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STRUCTURAL DETAILS

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0179
DATE: 11-NOV-2022
SHEET
A-002

CONSTRUCTION DOCUMENTS

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DESIGNED BY: Designer
DRAWN BY: Drafter APPROVED BY: Approver

WE RECYCLE
THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK
WHITE

DEMOLITION KEY

KEY VALUE	KEYNOTE TEXT
D1	MECHANICAL EQUIPMENT. COORDINATE WITH MECHANICAL DRAWINGS. PATCH AND REPAIR ADJACENT SURFACES AT AREAS OF ALL MECHANICAL DEMOLITION TO MATCH EXISTING AND/OR AS REQUIRED FOR COMPLETION OF NEW WORK.
D3	REMOVE EXISTING LOUVER AND STRUCTURAL STEEL LINTEL AS REQUIRED FOR NEW WORK. PROTECT EXISTING STONE SILL THAT IS TO REMAIN. IF CONSTRUCTION REQUIRES STONE SILL TO BE REMOVED AS PART OF MEANS AND METHOD, CONTRACTOR SHALL SALVAGE AND PROTECT EXISTING STONE SILL FOR REINSTALLATION WHERE REQUIRED. INCLUDE, BUT NOT LIMITED TO ALL TRIM, ANCHORS, SEALANTS, ETC. PREPARE OPENING FOR NEW WORK. ALL MASONRY REPAIR WORK IS TO BE TOOTHED INTO EXISTING.
D4	SAWCUT AND REMOVE EXTERIOR WALL FOR NEW OPENING AS REQUIRED FOR NEW MECHANICAL WORK. PATCH AND REPAIR TO MATCH EXISTING. ALL MASONRY REPAIR WORK IS TO BE TOOTHED INTO EXISTING.
D5	CUT PIPES FLUSH W/ FLOOR AND FILL PIPE WITH NON-SHRINK GROUT FLUSH WITH FLOOR AS REQUIRED FOR NEW WORK. COORDINATE WITH MECHANICAL DRAWINGS. PATCH AND REPAIR FLOOR AS REQUIRED FOR INSTALLATION OF NEW FINISHES.
D6	SAWCUT AND REMOVE EXTERIOR WALL LOCATED IN FORMER CLEARSTORY GLASS BLOCK WINDOW FOR NEW OPENING AS REQUIRED FOR NEW MECHANICAL WORK. COORDINATE WITH MECHANICAL DRAWINGS. PATCH AND REPAIR ADJACENT SURFACES AT AREAS OF REMOVAL TO MATCH EXISTING AND/OR AS REQUIRED FOR PROPER INSTALLATION OF NEW FINISHES.
D7	REMOVE DOOR LATCHING HARDWARE. PREPARE FOR NEW PANIC HARDWARE. EXISTING FRAME, DOOR PANEL, AND REMAINING HARDWARE IS TO REMAIN.
D8	CABINET MODIFICATIONS. REMOVE MILLWORK AND/OR WALL MOUNTED SHELVING INCLUDING ANY ASSOCIATED BRACING SUPPORTS, BRACKETS, AND ANCHORS AS NECESSARY FOR INSTALLATION OF NEW FINISHES OR CASEWORK. PATCH AND REPAIR ADJACENT SURFACES AT AREAS OF REMOVAL TO MATCH EXISTING AND/OR AS REQUIRED FOR PROPER INSTALLATION OF NEW FINISHES OR CASEWORK. ETC.
D9	REMOVE WALL BASE AND ADHESIVE OR MORTAR AS REQUIRED FOR PROPER INSTALLATION OF NEW BASE MATERIAL. PATCH AND REPAIR ADJACENT WALL/FLOOR SURFACES AT AREAS OF REMOVAL TO MATCH EXISTING AND/OR AS REQUIRED FOR PROPER INSTALLATION OF NEW FINISHES.
D10	REMOVE TACK STRIP(S). PATCH AND REPAIR AFFECTED SURFACES AT AREAS OF REMOVAL TO MATCH EXISTING AND/OR AS REQUIRED FOR PROPER INSTALLATION OF NEW FINISHES.
D11	REMOVE AND SALVAGE EXISTING WALL MOUNTED SHELVES ON STANDARDS AND BRACKETS FOR REINSTALLATION. PATCH AND REPAIR AFFECTED SURFACES AT AREAS OF REMOVAL TO MATCH EXISTING AND/OR AS REQUIRED FOR PROPER INSTALLATION OF NEW FINISHES. CONTRACTOR TO DOCUMENT MOUNTING HEIGHT PRIOR TO REMOVAL.
D12	REMOVE AND SALVAGE ALL WALL MOUNTED EQUIPMENT THAT WILL CONFLICT WITH NEW MECHANICAL WORK. CONTRACTOR TO REVIEW EACH EXISTING CONDITION PRIOR TO BIDDING AND AGAIN AT THE START OF CONSTRUCTION AS WALL MOUNTED EQUIPMENT VARY FROM ROOM TO ROOM. PATCH AND REPAIR AFFECTED SURFACES AT AREAS OF REMOVAL TO MATCH EXISTING AND/OR AS REQUIRED FOR PROPER INSTALLATION OF NEW FINISHES. CONTRACTOR TO DOCUMENT MOUNTING HEIGHT PRIOR TO REMOVAL.

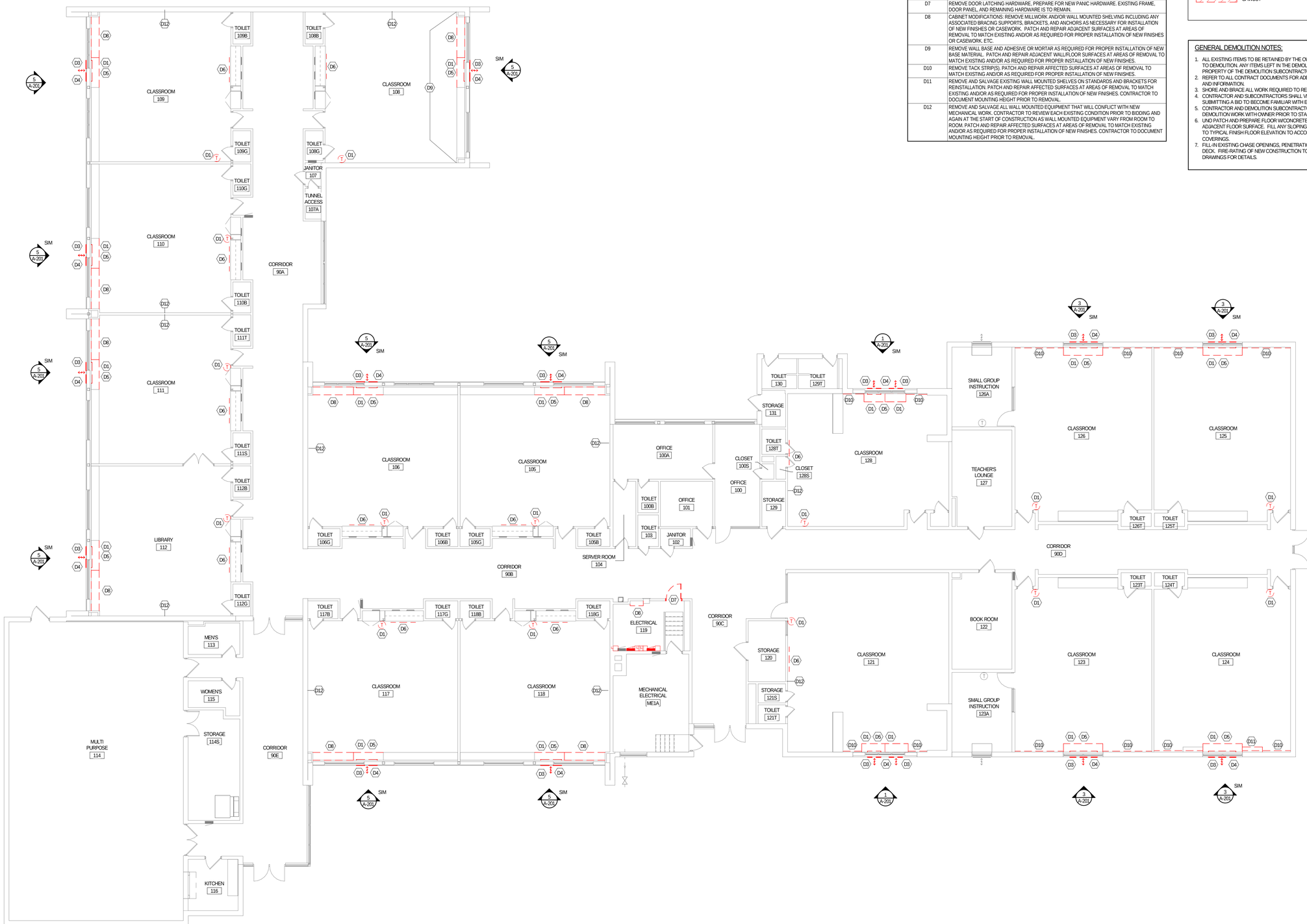
DEMO PLAN LEGEND:

- EXISTING WALL OR PARTITION TO REMAIN
- EXISTING WALL/PARTITION OR EXISTING ITEMS TO BE REMOVED
- EXISTING DOOR TO REMAIN
- EXISTING DOOR & FRAME TO BE REMOVED
- EXISTING BUILDING COMPONENT & STRUCTURE TO REMAIN
- EXISTING ASSEMBLY TO BE REMOVED
- EXISTING FLOOR SLAB TO BE SAWCUT

NOTE: ALL ITEMS SHOWN RED AND DASHED ARE TO BE DEMOLISHED- UNO

GENERAL DEMOLITION NOTES:

1. ALL EXISTING ITEMS TO BE RETAINED BY THE OWNER WILL BE REMOVED PRIOR TO DEMOLITION. ANY ITEMS LEFT IN THE DEMOLITION AREA BECOME THE PROPERTY OF THE DEMOLITION SUBCONTRACTOR.
2. REFER TO ALL CONTRACT DOCUMENTS FOR ADDITIONAL DEMOLITION NOTES AND INFORMATION.
3. SHORE AND BRACE ALL WORK REQUIRED TO REMAIN.
4. CONTRACTOR AND SUBCONTRACTORS SHALL VISIT THE SITE PRIOR TO SUBMITTING A BID TO BECOME FAMILIAR WITH EXISTING CONDITIONS.
5. CONTRACTOR AND DEMOLITION SUBCONTRACTOR TO COORDINATE DEMOLITION WORK WITH OWNER PRIOR TO START OF WORK.
6. UNO PATCH AND PREPARE FLOOR W/CONCRETE (OR FLORSTONE) FLUSH WITH ADJACENT FLOOR SURFACE. FILL ANY SLOPING OF RECESSED AREAS LEVEL TO TYPICAL FINISH FLOOR ELEVATION TO ACCOMMODATE NEW FLOOR COVERINGS.
7. FILL-IN EXISTING CHASE OPENINGS, PENETRATIONS IN THE FLOOR AND CEILING DECK. FIRE-RATING OF NEW CONSTRUCTION TO MATCH EXISTING. REFER TO DRAWINGS FOR DETAILS.



DEMOLITION PLAN
1/8" = 1'-0"

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DEMOLITION PLAN

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0179
DATE: 11-NOV-2022
SHEET
AD101

CONSTRUCTION DOCUMENTS

11/11/2022 3:40:43 PM
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DESIGNED BY: Designer
DRAWN BY: Drafter APPROVED BY: Approver

DOOR AND FRAME SCHEDULE

DOOR NO.	ROOM NO.	ROOM NAME	DOOR SIZE WD.	DOOR SIZE HGT	DOOR TYPE	FRAME TYPE	FIRE RATING	HARDWARE SET NO.	NOTES
FLOOR LEVEL									
119.1	119	ELECTRICAL	3' - 0"	6' - 8"	EXIST	EXIST	45 MIN	01	EXISTING DOOR AND FRAME TO REMAIN, NEW PARTIAL HARDWARE ONLY

DOOR & FRAME GENERAL NOTES:

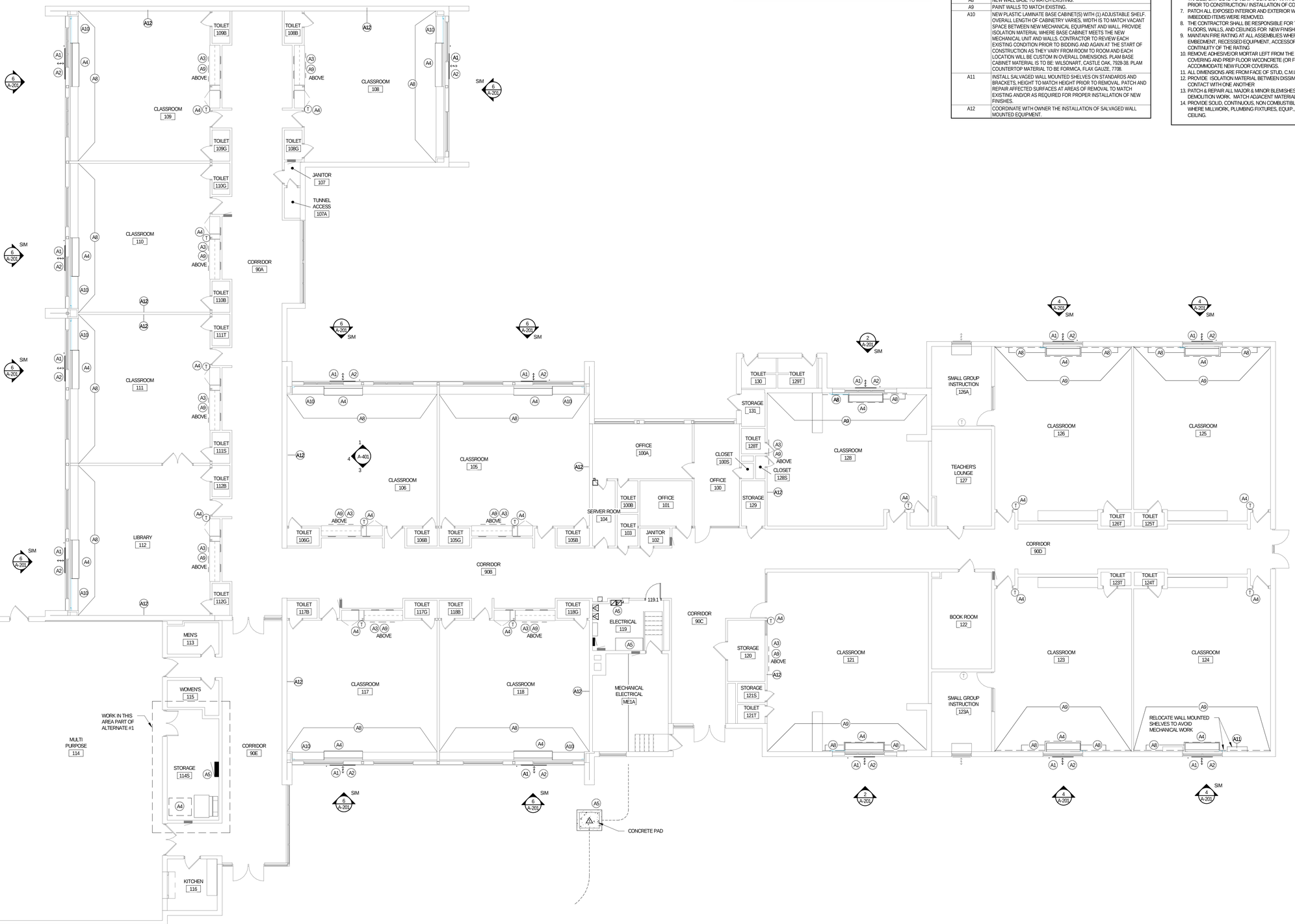
1. REFER TO SPECIFICATIONS FOR HARDWARE SETS.
2. EXIST= EXISTING
3. VERIFY EXISTING DOORS AND FRAMES SCHEDULED FOR USE IN RATED WALLS ARE RATED FOR SUCH USE. PROVIDE NEW WHERE REQUIRED.
4. ALL SIDELIGHTS AND TRANSOMS IN 20 MINUTE CORRIDOR DOORS MUST HAVE 3/4 HOUR RATING.

FLOOR PLAN KEY

KEY VALUE	KEYNOTE TEXT
A1	PROVIDE NEW LOUVER AND STEEL LINTEL AS REQUIRED FOR NEW MECHANICAL EQUIPMENT. REFER TO THE LOOSE LINTEL SCHEDULE FOR INFORMATION ON THE NEW STEEL LINTEL. COORDINATE LOUVER SIZE WITH MECHANICAL DRAWINGS. FINAL PLACEMENT OF LOUVER IS DETERMINED BY MECHANICAL EQUIPMENT. PATCH AND REPAIR ALL ADJACENT WALL INFILL TO MATCH EXISTING. ALL MASONRY REPAIR WORK IS TO BE TOOTHED INTO EXISTING.
A2	INFILL EXISTING WALL OPENING WITH NEW MATERIALS TO MATCH EXISTING. ALL MASONRY REPAIR WORK IS TO BE TOOTHED INTO EXISTING. PATCH AND REPAIR ALL SURFACES AS REQUIRED FOR PROPER INSTALLATION OF NEW FINISHES.
A3	NEW MECHANICAL EQUIPMENT INSTALLED IN EXTERIOR WALL LOCATED IN FORMER CLEARSTORY GLASS BLOCK WINDOW. COORDINATE WITH MECHANICAL DRAWINGS. PATCH AND REPAIR ADJACENT SURFACES AT AREAS OF REMOVAL TO MATCH EXISTING AND/OR AS REQUIRED FOR PROPER INSTALLATION OF NEW FINISHES.
A4	MECHANICAL EQUIPMENT. COORDINATE WITH MECHANICAL DRAWINGS.
A5	ELECTRICAL EQUIPMENT. COORDINATE WITH ELECTRICAL DRAWINGS.
A8	NEW WALL BASE TO MATCH EXISTING.
A9	PAINT WALLS TO MATCH EXISTING.
A10	NEW PLASTIC LAMINATE BASE CABINET(S) WITH (1) ADJUSTABLE SHELF. OVERALL LENGTH OF CABINETRY VARIES, WIDTH IS TO MATCH VACANT SPACE BETWEEN NEW MECHANICAL EQUIPMENT AND WALL. PROVIDE ISOLATION MATERIAL WHERE BASE CABINET MEETS THE NEW MECHANICAL UNIT AND WALLS. CONTRACTOR TO REVIEW EACH EXISTING CONDITION PRIOR TO BIDDING AND AGAIN AT THE START OF CONSTRUCTION AS THEY VARY FROM ROOM TO ROOM AND EACH LOCATION WILL BE CUSTOM IN OVERALL DIMENSIONS. PLAM BASE CABINET MATERIAL IS TO BE: WILSONART, CASTLE OAK, 7929-38. PLAM COUNTERTOP MATERIAL TO BE FORMICA, FLAX GAUZE, 7708.
A11	INSTALL SALVAGED WALL MOUNTED SHELVES ON STANDARDS AND BRACKETS, HEIGHT TO MATCH HEIGHT PRIOR TO REMOVAL. PATCH AND REPAIR AFFECTED SURFACES AT AREAS OF REMOVAL TO MATCH EXISTING AND/OR AS REQUIRED FOR PROPER INSTALLATION OF NEW FINISHES.
A12	COORDINATE WITH OWNER THE INSTALLATION OF SALVAGED WALL MOUNTED EQUIPMENT.

GENERAL NOTES:

1. SUB-CONTRACTORS ARE TO COORDINATE WORK WITH ALL OTHER TRADES.
2. CONFLICTS BETWEEN NOTES, DETAILS, SPECIFICATIONS, ETC., SHALL BE VERIFIED WITH THE OWNER'S REPRESENTATIVE OR THE MOST STRINGENT PROVISIONS SHALL GOVERN.
3. DETAILS OF CONSTRUCTION NOT FULLY SHOWN SHALL BE OF THE SAME NATURE AS SHOWN FOR SIMILAR CONDITIONS. ANY UNCLEAR CONDITIONS SHALL BE VERIFIED WITH OWNER'S REPRESENTATIVE PRIOR TO CONSTRUCTION OF THAT AREA.
4. DRAWINGS ARE NOT TO BE SCALED. ANY UNCLEAR DIMENSIONS OR DIMENSIONAL DISCREPANCIES SHALL BE VERIFIED WITH OWNER'S REPRESENTATIVE.
5. ALL EXISTING CONDITIONS AND ALL RELATED DIMENSIONS INDICATED IN THE CONTRACT DOCUMENTS SHALL BE FIELD VERIFIED PRIOR TO FABRICATION, ERECTION, AND/OR CONSTRUCTION. ANY CONDITIONS THAT DIFFER FROM THAT INDICATED IN THE CONTRACT DOCUMENTS SHALL BE SUBMITTED TO THE OWNER'S REPRESENTATIVE FOR REVIEW PRIOR TO FABRICATION, ERECTION, AND/OR CONSTRUCTION.
6. CONSTRUCTION MANAGER (CM) / GENERAL CONTRACTOR (GC) TO REVIEW ENTIRE SET OF CONSTRUCTION DOCUMENTS AND SHALL COORDINATE WORK BETWEEN ALL TRADES. IF CONFLICTS ARISE DUE TO COORDINATION OF TRADES, CM / GC IS TO VERIFY CONFLICT WITH OWNER'S REPRESENTATIVE PRIOR TO CONSTRUCTION / INSTALLATION OF CONFLICTING ITEMS.
7. PATCH ALL EXPOSED INTERIOR AND EXTERIOR WALLS WHERE ATTACHED OR IMBEDDED ITEMS WERE REMOVED.
8. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PREPARATIONS OF THE FLOORS, WALLS, AND CEILINGS FOR NEW FINISHES.
9. MAINTAIN FIRE RATING AT ALL ASSEMBLIES WHERE OPENINGS PENETRATIONS, EMBEDMENT, RECESSED EQUIPMENT, ACCESSORIES, ETC. DISRUPT THE CONTINUITY OF THE RATING
10. REMOVE ADHESIVE/OR MORTAR LEFT FROM THE REMOVAL OF EXISTING FLOOR COVERING AND PREP FLOOR W/CONCRETE (OR FLORSTONE) AS NECESSARY TO ACCOMMODATE NEW FLOOR COVERINGS.
11. ALL DIMENSIONS ARE FROM FACE OF STUD, C.M.U., OR CONCRETE., U.N.O.
12. PROVIDE ISOLATION MATERIAL BETWEEN DISSIMILAR MATERIALS THAT ARE IN CONTACT WITH ONE ANOTHER
13. PATCH & REPAIR ALL MAJOR & MINOR BLEMISHES AS REQ'D. DUE TO DEMOLITION WORK. MATCH ADJACENT MATERIAL & COLOR.
14. PROVIDE SOLID, CONTINUOUS, NON COMBUSTIBLE BLOCKING AT LOCATIONS WHERE MILLWORK, PLUMBING FIXTURES, EQUIP., ETC. ATTACH TO WALL OR CEILING.



FLOOR PLAN
1/8" = 1'-0"

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FLOOR PLAN

REVISIONS

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SHEET
A-101

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THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK
WE RECYCLE
WHITE

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DESIGNED BY: Designer
CHECKED BY: Checker APPROVED BY: Approver

THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK
WHITE
WE RECYCLE

ROOF KEY

KEY VALUE	KEYNOTE TEXT
R1	NEW MECHANICAL EQUIPMENT AND MECHANICAL CURB. REMOVE ROOF MEMBRANE AND INSULATION DOWN TO EXISTING ROOF DECK AS REQUIRED FOR NEW MECHANICAL CURB. REFER TO MECHANICAL DRAWINGS FOR LOCATION AND SIZES OF ROOF DECK PENETRATIONS. CONTRACTOR IS RESPONSIBLE FOR IDENTIFYING ACTUAL ROOF CONSTRUCTION. PATCH AND REPAIR ROOF WITH SIMILAR MATERIALS USING MEANS AND METHODS AS REQUIRED TO MAINTAIN ALL ROOF WARRANTIES. CONTRACTOR TO LOCATE EXISTING ROOF DRAINS. PROVIDE 1/2" PER FOOT TAPERED CRICKETS AT NEW CURB AS REQUIRED TO PROVIDE PROPER WATER DRAINAGE AROUND EQUIPMENT TOWARDS CLOSEST ROOF DRAIN.
R2	NEW MECHANICAL EQUIPMENT WITH SURFACE SUPPORTS. CLEAN EXISTING ROOF SYSTEM AND PROVIDE SELF ADHERING PROTECTION SHEET UNDER SURFACE SUPPORTS. NO ROOF WORK.
R3	NEW MECHANICAL EQUIPMENT INSTALLED IN EXTERIOR WALL LOCATED IN FORMER CLEARSTORY GLASS BLOCK WINDOW. COORDINATE WITH MECHANICAL DRAWINGS. PATCH AND REPAIR ADJACENT SURFACES AT AREAS OF REMOVAL TO MATCH EXISTING AND/OR AS REQUIRED FOR PROPER INSTALLATION OF NEW FINISHES.

ROOF DEMOLITION NOTES:

1. DEMOLITION NOTES MAY NOT FULLY REPRESENT ALL DEMOLITION WORK THAT MAY BE REQUIRED TO INSTALL NEW WORK IN ACCORDANCE WITH THE CONTRACT DOCUMENTS BUT ARE INTENDED TO SERVE AS GENERAL DEMOLITION GUIDELINES.
2. THE CONTRACTOR SHALL COORDINATE PHASING AND SEQUENCING OF DEMOLITION TO MAINTAIN BUILDING SECURITY AND WEATHER-TIGHTNESS. COORDINATE AND PHASE DEMOLITION IN ACCORDANCE WITH PLANS AND SPECIFICATIONS IN ORDER TO MAINTAIN CONTINUING OPERATIONS FOR THE OWNER.

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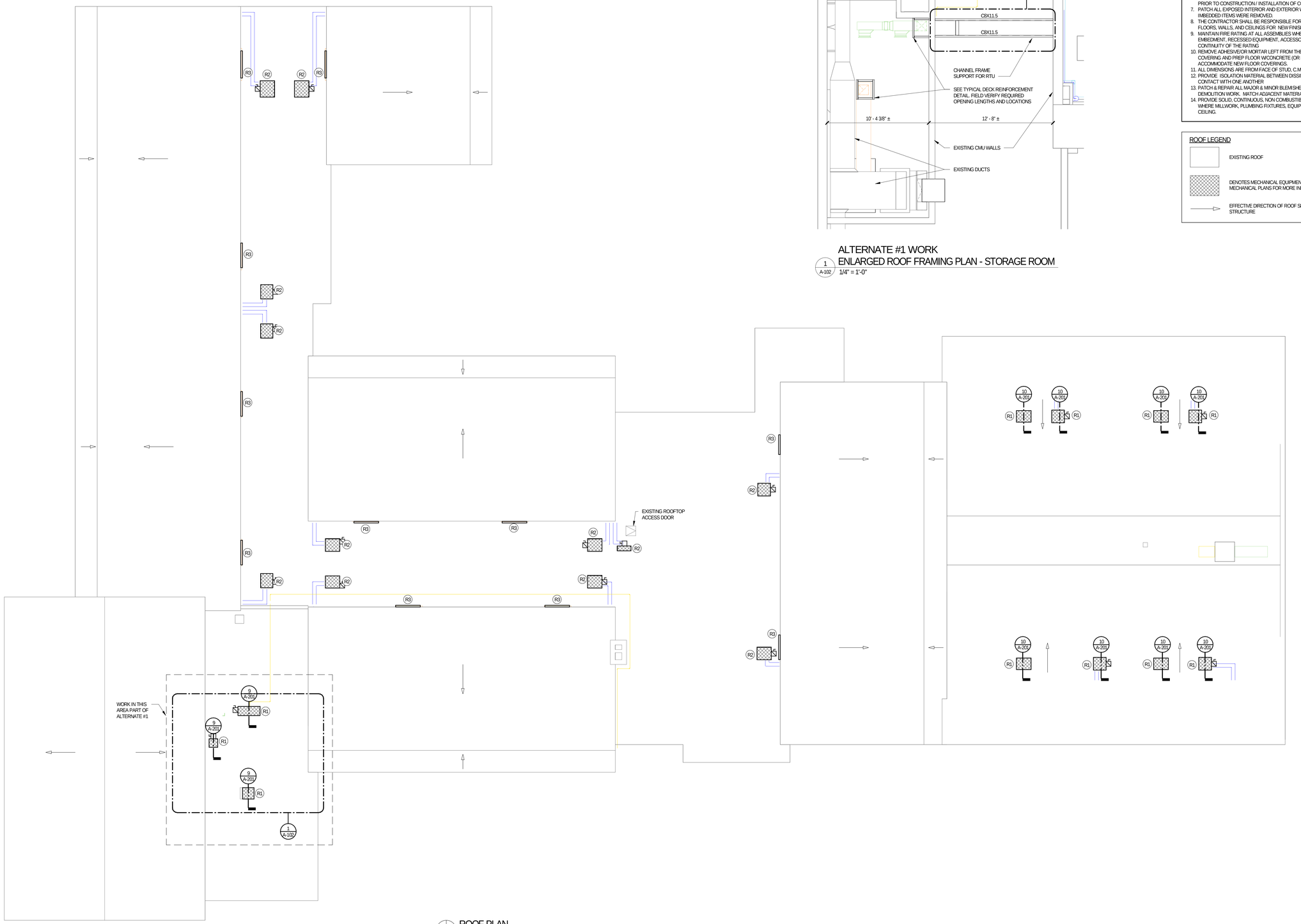
ROOF LEGEND

- EXISTING ROOF
- DENOTES MECHANICAL EQUIPMENT, SEE MECHANICAL PLANS FOR MORE INFORMATION
- EFFECTIVE DIRECTION OF ROOF SLOPE DUE TO STRUCTURE

ALTERNATE #1 WORK
ENLARGED ROOF FRAMING PLAN - STORAGE ROOM
1 A-102 1/4" = 1'-0"



ROOF PLAN
1/8" = 1'-0"

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ROOF PLAN

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CONSTRUCTION DOCUMENTS

11/11/2022 3:40:27 PM
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DESIGNED BY: Designer
CHECKED BY: Checker APPROVED BY: Approver

WE RECYCLE
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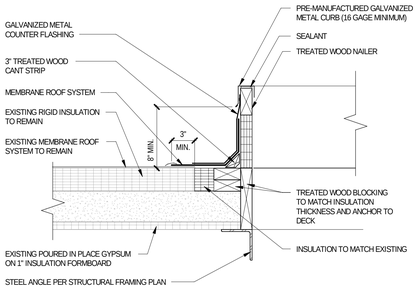
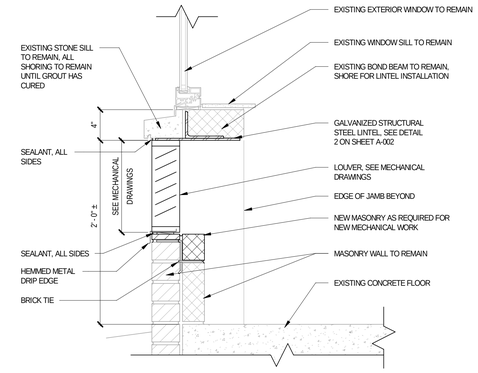
WHITE



10 A-102 ROOF CURB DETAIL
1 1/2" = 1'-0"



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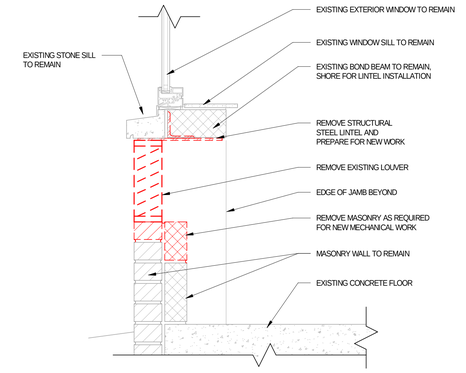
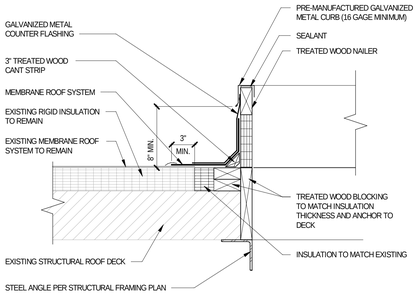


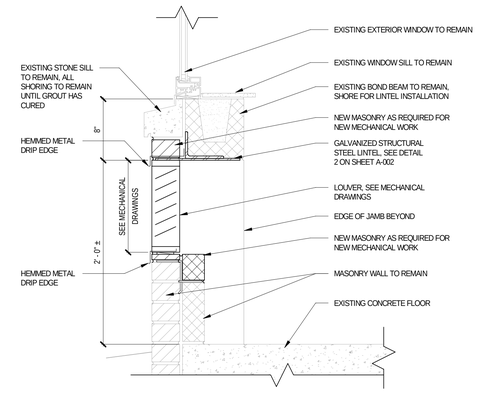
DEMO

8 A-201 WALL SECTION - THROUGH LOUVER
1 1/2" = 1'-0"



ALTERNATE #1 WORK

9 A-102 ROOF CURB DETAIL
1 1/2" = 1'-0"



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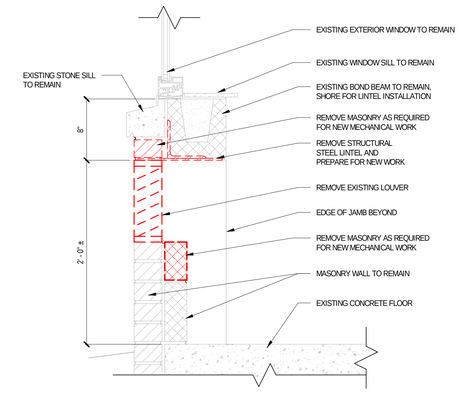
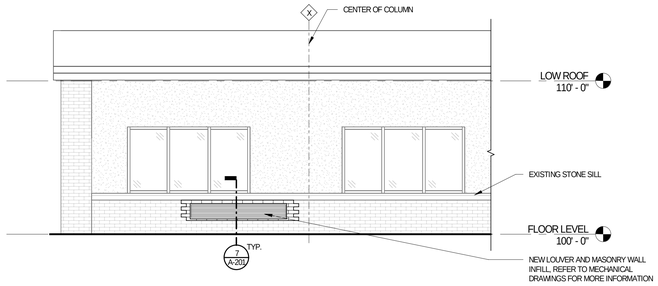
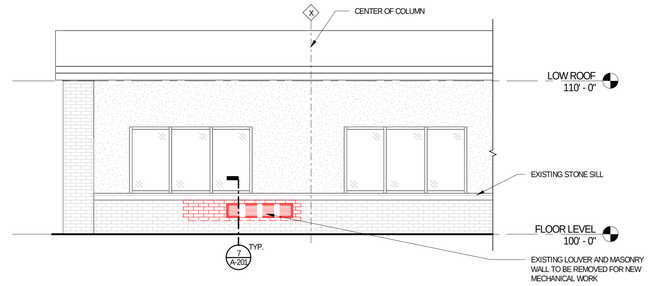


DEMO

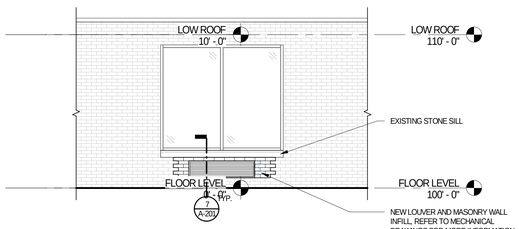
7 A-201 WALL SECTION - THROUGH LOUVER
1 1/2" = 1'-0"



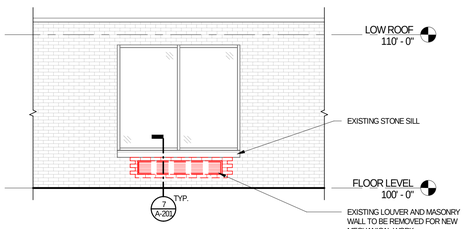
6 A-101 EXTERIOR ELEVATION - EAST - CLASSROOM 109 NEW
1/4" = 1'-0"



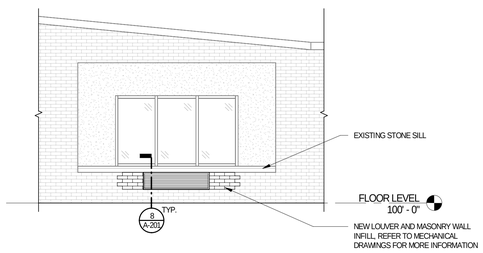
5 AD101 EXTERIOR ELEVATION - EAST - CLASSROOM 109 DEMO
1/4" = 1'-0"



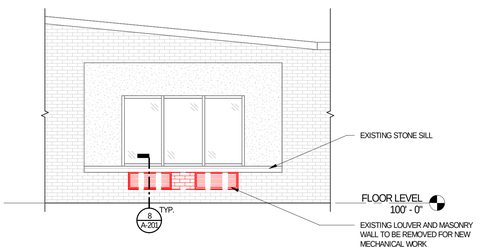
4 A-101 EXTERIOR ELEVATION - NORTH - CLASSROOM 123 NEW
1/4" = 1'-0"



3 AD101 EXTERIOR ELEVATION - NORTH - CLASSROOM 123 DEMO
1/4" = 1'-0"



2 A-101 EXTERIOR ELEVATION - NORTH - CLASSROOM 121 NEW
1/4" = 1'-0"



1 AD101 EXTERIOR ELEVATION - NORTH - CLASSROOM 121 DEMO
1/4" = 1'-0"

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EXTERIOR ELEVATIONS

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0179
DATE: 11-NOV-2022
SHEET
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CONSTRUCTION DOCUMENTS

11/11/2022 3:40:38 PM
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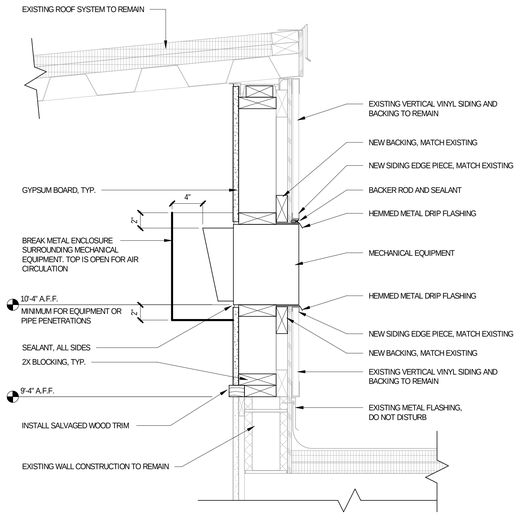
DESIGNED BY: Designer
CHECKED BY: Checker APPROVED BY: Approver

THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK
WHITE
WE RECYCLE



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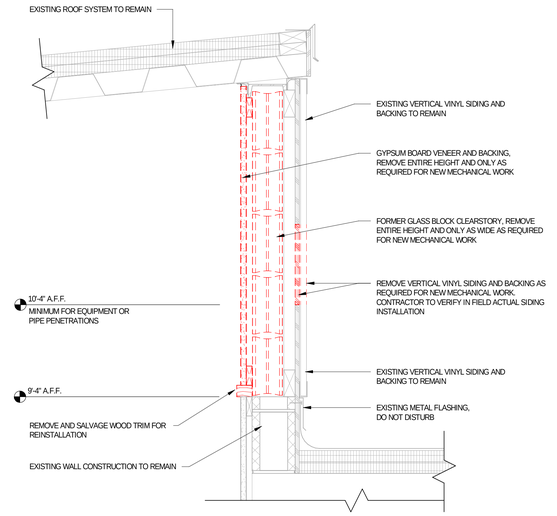

DEMO

FLOOR PLAN KEY

KEY VALUE	KEYNOTE TEXT
A4	MECHANICAL EQUIPMENT. COORDINATE WITH MECHANICAL DRAWINGS.
A8	NEW WALL BASE TO MATCH EXISTING.
A9	PAINT WALLS TO MATCH EXISTING.
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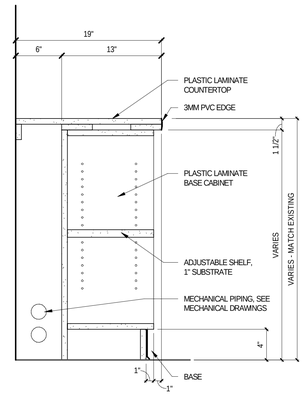
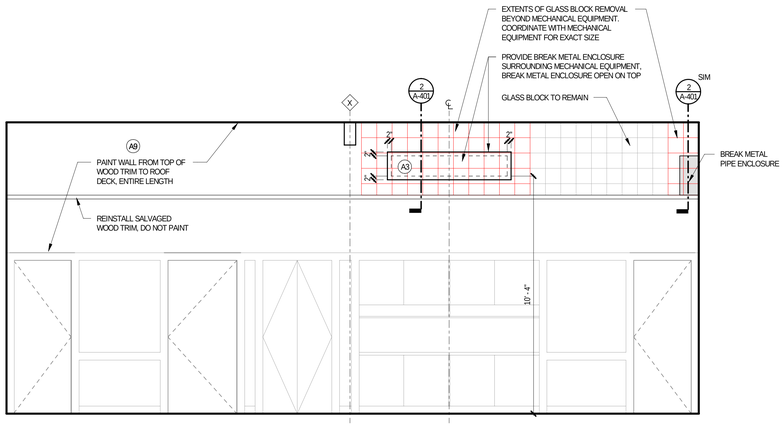
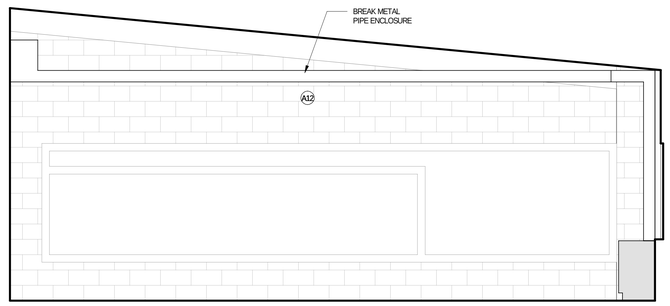


9 A-401 OPEN BASE CABINET
1 1/2" = 1'-0"

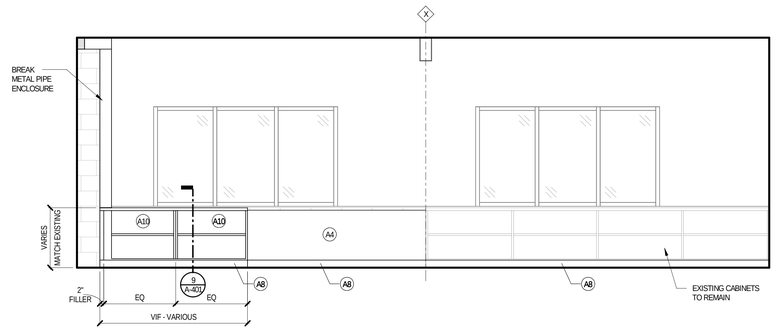
2 A-401 CLEARSTORY WORK
1 1/2" = 1'-0"



3 A-101 CLASSROOM 106 - SOUTH
3/8" = 1'-0"



4 A-101 CLASSROOM 106 - WEST
3/8" = 1'-0"



1 A-101 CLASSROOM 106 - NORTH
3/8" = 1'-0"

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INTERIOR ELEVATIONS

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DESIGNER: Designer
CHECKED BY: Checker APPROVED BY: Approver

WE RECYCLE

THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK

WHITE

PIPING COMPONENTS

SYMBOL	
	ISOLATION VALVE (GENERIC)
	GATE VALVE
	GLOBE VALVE
	BUTTERFLY VALVE NPS 6 AND LESS
	BUTTERFLY VALVE NPS 8 AND MORE
	BALL VALVE
	PLUG VALVE
	NEEDLE VALVE
	CHECK VALVE (GENERIC)
	BALANCING VALVE
	FLOW LIMITING VALVE
	PRESSURE REDUCING VALVE
	2-WAY CONTROL VALVE (GENERIC)
	3-WAY CONTROL VALVE (GENERIC)
	SOLENOID 2-WAY CONTROL VALVE
	SOLENOID 3-WAY CONTROL VALVE
	FLOAT OPERATED VALVE ACTUATOR
	SAFETY OR RELIEF VALVE
	ANGLE VALVE
	BOILER STOP AND CHECK VALVE
BFP	BACKFLOW PREVENTER (GENERIC)
	MULTI-PURPOSE VALVE (SHUTOFF, BALANCING AND CHECK)
	PUMP (GENERIC)
	Y STRAINER (GENERIC)
	STEAM TRAP (GENERIC)
	AUTOMATIC AIR VENT
	MANUAL AIR VENT
	VACUUM BREAKER
	SHOCK ABSORBER
	TEMPERATURE GAUGE
	PRESSURE GAUGE
	TEMPERATURE AND PRESSURE TAP
	SIGHT FLOW GLASS
	FLEXIBLE CONNECTOR
	EXPANSION JOINT
	GUIDE
	ANCHOR
	FLOW ARROW
1%	PIPING SLOPE
	PIPE CAP
	PIPE BREAK
	PIPE CROSS
	PIPING ELBOW UP
	PIPING ELBOW DOWN
	PIPING TEE UP
	PIPING TEE DOWN
	UNION CONNECTION
	FLANGED CONNECTION
	CONCENTRIC REDUCER
	ECCENTRIC REDUCER
CO	STANDARD CLEAN-OUT IN LINE END OF RUN
CO	STANDARD CLEAN-OUT THROUGH FLOOR END OF RUN
CO	STANDARD CLEAN-OUT THROUGH FLOOR IN LINE

PIPING SYSTEMS (HVAC)

2 1/2"	PIPE SIZE
BBD	BOILER BLOWDOWN
BFW	BOILER FEED WATER
BR	BRINE RETURN
BS	BRINE SUPPLY
CHWR	CHILLED WATER RETURN
CHWR(G)	CHILLED WATER RETURN - GLYCOL
CHWR(P)	CHILLED WATER RETURN - PROCESS
CHWS	CHILLED WATER SUPPLY
CHWS(G)	CHILLED WATER SUPPLY - GLYCOL
CHWS(P)	CHILLED WATER SUPPLY - PROCESS
CWR	CONDENSER WATER RETURN
CWR(CT)	CONDENSER WATER RETURN (COOLING TOWER)
CWS	CONDENSER WATER SUPPLY
CWS(CT)	CONDENSER WATER SUPPLY (COOLING TOWER)
DTR	DUAL TEMPERATURE RETURN (HOT OR CHILLED)
DTS	DUAL TEMPERATURE SUPPLY (HOT OR CHILLED)
FOF	FUEL OIL FILL
FOR	FUEL OIL RETURN
FOS	FUEL OIL SUPPLY
FOV	FUEL OIL VENT
HPWR	HEAT PUMP WATER RETURN
HPWS	HEAT PUMP WATER SUPPLY
HRR	HEAT RECOVERY LOOP RETURN
HRS	HEAT RECOVERY LOOP SUPPLY
HWR	HEATING WATER RETURN
HWR(G)	HEATING WATER RETURN - GLYCOL
HWS	HEATING WATER SUPPLY
HWS(G)	HEATING WATER SUPPLY - GLYCOL
G	NATURAL GAS
GV	NATURAL GAS VENT
PG	PROPANE GAS
REF(HG)	REFRIGERANT HOT GAS
REF(L)	REFRIGERANT LIQUID
REF(S)	REFRIGERANT SUCTION
REF(V)	REFRIGERANT VENT
RV	RELIEF VENT
S(##)	STEAM (NOMINAL PRESSURE)
CS(##)	STEAM - CLEAN (NOMINAL PRESSURE)
C(##)	STEAM CONDENSATE (NOMINAL PRESSURE)
PC(##)	STEAM PUMPED CONDENSATE (NOMINAL PRESSURE)
SV	STEAM VENT
	PIPE INSULATION

VENTILATION (HVAC)

	AIR FLOW ARROW
18"x12" 18"x12"	RECTANGULAR DUCT AND SIZE*
18"ø 18"ø	ROUND DUCT AND SIZE*
18"x12"ø 18"x12"ø	FLAT OVAL DUCT AND SIZE*
18"x12"	EXTERIOR DUCT TREATMENT*
18"x12" 18"x12"	RECTANGULAR DUCT WITH ACOUSTIC LINING*
30"x12"	DUCT SECTION, SUPPLY AIR. SIZE* IS HORIZONTAL DIM. x VERTICAL DIM. APPLIES TO RECT., ROUND AND OVAL
	DUCT SECTION, OUTSIDE AIR. APPLIES TO RECT., ROUND AND OVAL
	DUCT SECTION, RETURN AIR. APPLIES TO RECT., ROUND AND OVAL
	DUCT SECTION, EXHAUST AIR. APPLIES TO RECT., ROUND AND OVAL
	FLEXIBLE DUCT
	ELBOW TURN, SUPPLY DOWN. APPLIES TO RECT., ROUND AND OVAL
	ELBOW TURN, OUTSIDE AIR DOWN. APPLIES TO RECT., ROUND AND OVAL
	ELBOW TURN, RETURN DOWN. APPLIES TO RECT., ROUND AND OVAL
	ELBOW TURN, EXHAUST DOWN. APPLIES TO RECT., ROUND AND OVAL
UP	CHANGE IN DUCT ELEVATION RISING IN DIRECTION INDICATED
DN	CHANGE IN DUCT ELEVATION DROPPING IN DIRECTION INDICATED
	END CAP
	ELBOW, RECTANGULAR, SMOOTH RADIUS WITH SPLITTER VANES (0.25 R/W DEFAULT)
	ELBOW, RECTANGULAR, SMOOTH RADIUS WITHOUT VANES (1.5 R/W DEFAULT)
	ELBOW, ROUND, SMOOTH RADIUS (1.5 R/W DEFAULT)
	MITERED ELBOW, RECTANGULAR, WITH TURNING VANES
	RECTANGULAR TO ROUND TRANSITION
AD AD AD	DUCT ACCESS DOOR (TOP, SIDE, BOTTOM)
FC	FLEXIBLE CONNECTION

* NOTE: ALL DUCT SIZES ARE INTERIOR, FREE DIMENSIONS (ALWAYS WIDTH X HEIGHT IN FLOOR PLAN AND SECTION)

VENTILATION (HVAC)

BDD	BACKDRAFT DAMPER
	MANUAL DAMPER
M	MOTORIZED DAMPER
	FIRE DAMPER
	SMOKE DAMPER
	SMOKE AND FIRE DAMPER
	DUCT SILENCER
X	CONTROL DEVICE (REFER TO CONTROLS LEGEND)
	AIR FLOW MEASURING STATION (REFER TO CONTROLS LEGEND)
QUANTITY TYPE SIZE (IN.) VOLUME (CFM)	AIR OUTLET OR INLET TAG (REFER TO SCHEDULE)
	RECTANGULAR DIFFUSER, SUPPLY. OPTIONAL ARROWS SHOW THE FLOW DIRECTION.
	RECTANGULAR REGISTER OR GRILLE, RETURN
	RECTANGULAR REGISTER OR GRILLE, EXHAUST
	ROUND DIFFUSER, SUPPLY
	LINEAR DIFFUSER
	SIDEWALL REGISTER OR GRILLE, SUPPLY
	SIDEWALL GRILLE, RETURN OR EXHAUST
UC	UNDERCUT DOOR
	DOOR GRILLE OR LOUVER
	TRANSFER GRILLE OR LOUVER
	COIL (REFER TO CONTROLS LEGEND)
ID-#	EQUIPMENT TAG
QUANTITY TYPE LENGTH (FT) CAPACITY (MBH)	RADIATION HEATING TAG (REFER TO SCHEDULE)

GENERAL SYMBOLS

	DEMOLITION
	EXISTING
	NEW WORK
	POINT OF CONNECTION OF NEW TO EXISTING SYSTEM
	POINT OF DISCONNECTION OF DEMOLITION FROM EXISTING
	CAP OFF EXISTING
? ? ?	DETAIL NUMBER DETAIL CALLOUTS SHEET ON WHICH DETAIL IS SHOWN
? ? ?	SECTION NUMBER WALL SECTIONS SHEET ON WHICH SECTION IS SHOWN
FLOOR 0'-0"	FLOOR OR ROOF LEVEL NAME VERTICAL ELEVATION
N	NORTH ARROW
?	DRAWING REVISION
	MATCH LINE
	GRAPHIC SCALES - ENGINEERING
0000	ROOM TAG
M01	KEY NOTE TAG
SLOPE	SLOPE ARROW
	CIRCULAR BREAK SYMBOL
	CIRCLE BREAK SYMBOL
	CENTER LINE
	GRID BUBBLE AND LINE

EQUIPMENT IDENTIFICATION

AB-#	AIR BLENDER
AC-#	AIR COMPRESSOR
ACU-#	AIR CONDITIONING UNIT
ADS-#	AIR AND DIRT SEPARATOR
AF-#	AIR FILTER
AHU-#	AIR HANDLING UNIT
AS-#	AIR SEPARATOR
ATU-#	AIR TERMINAL UNIT
B-#	BOILER
BCU-#	BLOWER COIL UNIT
CB-#	CHILLED BEAM
CC-#	COOLING COIL
CH-#	CHILLER
CONV-#	CONVECTOR
CRU-#	CONDENSATE RETURN UNIT
CT-#	COOLING TOWER
CUH-#	CABINET UNIT HEATER
CU-#	CONDENSING UNIT
DAC-#	DOOR AIR CURTAIN
DC-#	DUST COLLECTOR
DCT-#	DECONTAMINATION TANK
DF-#	DRINKING FOUNTAIN
DS-#	DUCT SILENCER
DU-#	DEHUMIDIFICATION UNIT
DWH-#	DOMESTIC WATER HEATER
E-#	EXHAUST GRILLE / REGISTER / DIFFUSER
EL-#	EXPANSION LOOP
ERC-#	ENERGY RECOVERY COIL
ERU-#	ENERGY RECOVERY UNIT
EWC-#	ELECTRIC WATER COOLER
F-#	FAN
F(C)-#	FAN (CEILING)
F(E)-#	FAN (EXHAUST)
F(LE)-#	FAN (LABORATORY EXHAUST)
F(R)-#	FAN (RETURN)
F(S)-#	FAN (SUPPLY)
F(T)-#	FAN (TRANSFER)
FCU-#	FAN COIL UNIT
FD-#	FLOOR DRAIN
FFU-#	FAN FILTER UNIT
FP-#	FIRE PROTECTION PUMP
FPP-#	FIRE PROTECTION JOCKEY PUMP
FPTU-#	FAN POWERED TERMINAL UNIT
FTR-#	FINNED TUBE RADIATOR
FUR-#	FURNACE

EQUIPMENT IDENTIFICATION

GFS-#	GLYCOL FEED SYSTEM
GSG-#	GAS-FIRED STEAM GENERATOR
H-#	HUMIDIFIER
HC-#	HEATING COIL
HP-#	HEAT PUMP
HRU-#	HEAT RECOVERY UNIT
H(C)-#	HOOD (CANOPY)
H(HC)-#	HOOD (HEAT AND CONDENSATE)
H(I)-#	HOOD (INTAKE)
H(K)-#	HOOD (KITCHEN)
H(RH)-#	HOOD (RANGE)
H(R)-#	HOOD (RELIEF)
HX-#	HEAT ELAB AIR TERMINAL UNITXCHANGER
LATU-#	LAB AIR TERMINAL UNIT
LAV-#	LAVATORY
MAC-#	MEDICAL AIR COMPRESSOR
MAU-#	MAKEUP AIR UNIT
MV-#	MIXING VALVE
MVP-#	MEDICAL VACUUM PUMP
P-#	PUMP
PDU-#	POOL DEHUMIDIFICATION UNIT
PRV-#	PRESSURE REDUCING VALVE
PTAC-#	PACKAGED TERMIANL AIR CONDITIONER
RD-#	ROOF DRAIN
R-#	RETURN AIR GRILLE/ REGISTER / DIFFUSER
RP-#	RADIANT PANEL
RTU-#	ROOFTOP UNIT
S-#	SUPPLY GRILLE / REGISTER / DIFFUSER
SH-#	SHOWER
SK-#	SINK
SPC-#	SOLAR PANEL COLLECTOR
SSF-#	SIDE STEAM FILTER
T-#	TRANSFER AIR GRILLE
T(B)-#	TANK (BUFFER TANK)
T(E)-#	TANK (EXPANSION TANK)
T(H)-#	TANK (HYDRO PNEUMATIC TANK)
T(S)-#	TANK (STORAGE TANK)
UH-#	UNIT HEATER
UR-#	URINAL
USG-#	UNFIRED STEAM GENERATOR
UV-#	UNIT VENTILATOR
VA-#	VALVE
WC-#	WATER CLOSET
WS-#	WATER SOFTENER
ZN-#	ZONE

ABBREVIATIONS

AAV	AUTOMATIC AIR VENT
A/C	AIR CONDITIONING
ADA	AMERICANS WITH DISABILITIES ACT
ADJ	ADJUSTABLE
AFC	ABOVE FINISHED CEILING
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
AP	ACCESS PANEL / DOOR
APD	AIR PRESSURE DROP
AVG	AVERAGE
BAS	BUILDING AUTOMATION SYSTEM
BDD	BACKDRAFT DAMPER
BHP	BRAKE HORSEPOWER
BMS	BUILDING MANAGEMENT SYSTEM
BOD	BOTTOM OF DUCT
BOP	BOTTOM OF PIPE
BT	BATH TUB
BTU	BRITTISH THERMAL UNIT
BTUH	BRITTISH THERMAL UNIT PER HOUR
C	CELCIUS
CAV	CONSTANT AIR VOLUME
CFM	CUBIC FEET PER MINUTE
C/W	COMPLETE WITH
CV	CONTROL VALVE
dB	DECIBEL(S)
DB	DRY BULB TEMPERATURE
DDC	DIRECT DIGITAL CONTROL
DEG	DEGREE
DIA / Ø	DIAMETER
DIFF	DIFFERENTIAL
DIV	DIVISION
DN	DOWN
DWG	DRAWING
EAT	ENTERING AIR TEMPERATURE
EA	EXHAUST AIR
EA (D)	EXHAUST AIR (DISHWASH)
EA (G)	EXHAUST AIR (GENERAL)
EA (K)	EAXHAUST AIR (KITCHEN)
EA (LAB)	EXHAUST AIR (LAB)
EA (LD)	EXHAUST AIR (LAUNDRY/DRYER)
EAV	EXHAUST AIR VALVE
EA (W)	EXHAUST AIR (WASHROOM)
ED	EXISTING TO BE DEMOLOISHED
EER	ENERGY EFFICIENCY RATIO
EG	ETHELYEME GLYCOL
ER	EXISTING RELOCATED (IN NEW CONSTRUCTION)
ERL	EXISTING TO BE RELOCATED (IN DEMOLITION)
ESP	EXTERNAL STATIC PRESSURE
EEW	EYE WASH STATION
EWT	ENTERING WATER TEMPERATURE
EXIST / (E)	EXISTING
F	FAHRENHEIT
FLA	FULL LOAD AMPERAGE
FPM	FEET PER MINUTE
FPS	FEET PER SECOND
FT	FOOT / FEET
GA	GAUGE
GAL	GALLON
GC	GENERAL CONTRACTOR
GPM	GALLONS PER MINUTE
HEPA	HIGH EFFICIENCY PARTICULATE AIR (FILTER)
HP	HORSEPOWER
HR	HOUR
HVAC	HEATING / VENTILATION / AIR CONDITIONING

ABBREVIATIONS

HZ	HERTZ
IE	INVERT ELEVATION
IN	INCHES
IN WG	INCHES WATER GAUGE
IPLV	INTEGRATED PART LOAD VALUE
kW	KILOWATT
kWh	KILOWATT HOUR
LAT	LEAVING AIR TEMPEATURE
LBS	POUNDS
LF	LINEAR FEET
LWT	LEAVING WATER TEMPERATURE
M	METER
MAX	MAXIMUM
MBH	THOUSAND OF BTUH
MCA	MAXIMUM CIRCUIT AMPS
MFR	MANUFACTURER
MIN	MINIMUM
MOP	MAXIMUM OVERCURRENT PROTECTION
MSK	MOP SINK
N/A	NOT APPLICABLE
NC	NOISE CRITERIA
NC	NORMALLY CLOSED
NIC	NOT IN CONTRACT
NO	NORMALLY OPEN
NPS	NOMINAL PIPE SIZE
NTS	NOT TO SCALE
OA	OUTSIDE AIR
OFCI	OWNER FURNISHED, CONTRACTOR INSTALLED
OFE	OWNER FURNISHED EQUIPMENT
OFOI	OWNER FURNISHED / OWNER INSTALLED
PG	PROPYLENE GLYCOL
POE	POINT OF ENTRANCE
POS	POINT OF SERVICE
PPM	PARTS PER MILLION
PSI	POUNDS PER SQUARE INCH
PSIA	POUNDS PER SQUARE INCH, ABSOLUTE
PSIG	POUNDS PER SQUARE INCH, GAGE
PTS	PNEUMATIC TUBE STATION
PVC	POLYVINYL CHLORIDE
RA	RETURN AIR
RELA	RELIEF AIR
REQD	REQUIRED
RH	RELATIVE HUMIDITY
RPM	ROTATIONS PER MINUTE
SA	SUPPLY AIR
SP	STATIC PRESSURE
SP	STAIR PRESSURIZATION AIR
SRV	SAFETY RELIEF VALVE
TA	TRANSFER AIR
TEMP	TEMPERATURE
TSP	TOTAL STATIC PRESSURE
TSTAT	THERMOSTAT
TYP	TYPICAL
UC	UNDER CUT (DOOR)
UG	UNDERGROUND
VAV	VARIABLE AIR VOLUME
VFD	VARIABLE FREQUENCY DRIVE
VIF	VERIFY IN FIELD
VTR	VENT - THRU ROOF
W/	WITH
W/O	WITHOUT
WB	WET BULB TEMPERATURE
WG	WATER GAUGE

MECHANICAL SHEET LIST

NO.	DRAWING NAME	11-NOV-2022 CONSTRUCTION DOCUMENTS
M-001	MECHANICAL LEGEND, SYMBOLS, AND ABBREVIATIONS	•
MD100	MECHANICAL DEMOLITION PLAN - TUNNEL LEVEL	•
MD101	MECHANICAL DEMOLITION PLAN - FIRST LEVEL	•
M-100	MECHANICAL PLAN - TUNNEL LEVEL	•
M-101	MECHANICAL PLAN - FIRST LEVEL	•
M-102	MECHANICAL PLAN - ROOF LEVEL	•
M-501	MECHANICAL DETAILS	•
M-601	MECHANICAL SCHEDULES	•
M-602	MECHANICAL SCHEDULES	•
M-701	TEMPERATURE CONTROLS LEGEND AND DIAGRAMS	•

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MECHANICAL LEGEND, SYMBOLS, AND ABBREVIATIONS

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M-001

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MECHANICAL DEMOLITION KEYNOTES

MD1 REMOVE EXTENT OF (E) BRANCH STEAM AND STEAM CONDENSATE PIPING REQUIRED TO FACILITATE INSTALLATION OF NEW WORK. GROUT FLOOR OPENINGS SOLID AT PIPING PENETRATIONS. SEE NEW WORK PLANS FOR FURTHER REQUIREMENTS.

MECH DEMOLITION GENERAL NOTES

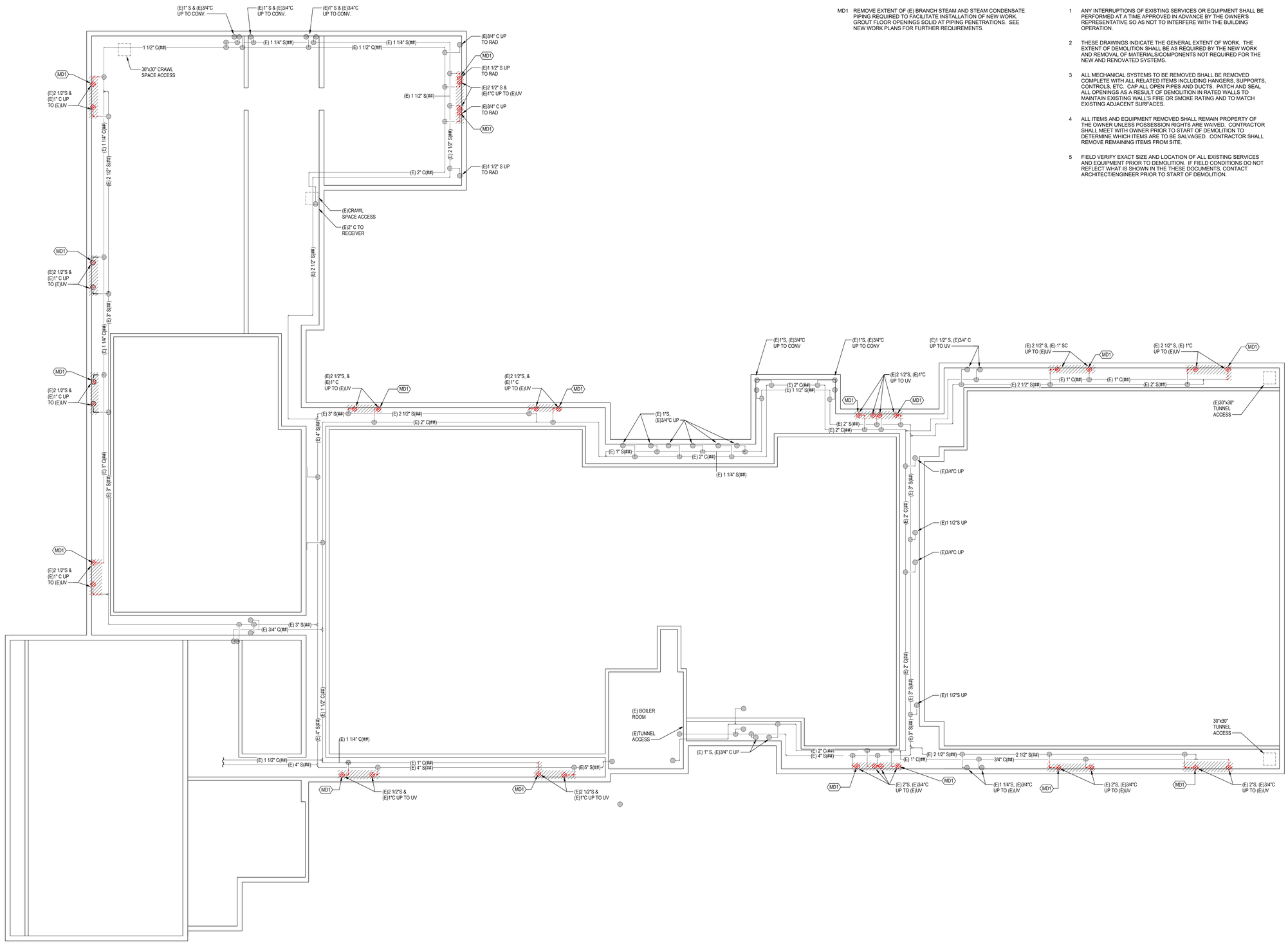
1 ANY INTERRUPTIONS OF EXISTING SERVICES OR EQUIPMENT SHALL BE PERFORMED AT A TIME APPROVED IN ADVANCE BY THE OWNER'S REPRESENTATIVE SO AS NOT TO INTERFERE WITH THE BUILDING OPERATION.

2 THESE DRAWINGS INDICATE THE GENERAL EXTENT OF WORK. THE EXTENT OF DEMOLITION SHALL BE AS REQUIRED BY THE NEW WORK AND REMOVAL OF MATERIALS/COMPONENTS NOT REQUIRED FOR THE NEW AND RENOVATED SYSTEMS.

3 ALL MECHANICAL SYSTEMS TO BE REMOVED SHALL BE REMOVED COMPLETE WITH ALL RELATED ITEMS INCLUDING HANGERS, SUPPORTS, CONTROLS, ETC. CAP ALL OPEN PIPES AND DUCTS. PATCH AND SEAL ALL OPENINGS AS A RESULT OF DEMOLITION IN RATED WALLS TO MAINTAIN EXISTING WALL'S FIRE OR SMOKE RATING AND TO MATCH EXISTING ADJACENT SURFACES.

4 ALL ITEMS AND EQUIPMENT REMOVED SHALL REMAIN PROPERTY OF THE OWNER UNLESS POSSESSION RIGHTS ARE WAIVED. CONTRACTOR SHALL MEET WITH OWNER PRIOR TO START OF DEMOLITION TO DETERMINE WHICH ITEMS ARE TO BE SALVAGED. CONTRACTOR SHALL REMOVE REMAINING ITEMS FROM SITE.

5 FIELD VERIFY EXACT SIZE AND LOCATION OF ALL EXISTING SERVICES AND EQUIPMENT PRIOR TO DEMOLITION. IF FIELD CONDITIONS DO NOT REFLECT WHAT IS SHOWN IN THE THESE DOCUMENTS, CONTACT ARCHITECT/ENGINEER PRIOR TO START OF DEMOLITION.



MECHANICAL DEMOLITION PLAN - TUNNEL LEVEL
1/8" = 1'-0"

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MECHANICAL DEMOLITION PLAN - TUNNEL LEVEL

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MECHANICAL DEMOLITION KEYNOTES

MD2 REMOVE (E) HORIZONTAL UNIT VENTILATOR, EXISTING STEAM AND STEAM CONDENSATE PIPING ASSEMBLY CONTAINED WITHIN UNIT CABINET, INCLUDING CONTROL VALVE, TRAP, ISOLATION VALVES AND STRAINER, AND CONTROLS TUBING COMPLETE. ELECTRICAL DISCONNECTION/MODIFICATION BY ELEC TRADES.

MD3 REMOVE (E)OA WALL SLEEVE AND EXTERIOR LOUVER COMPLETE. WALL OPENING MODIFICATION FOR NEW WORK BY ARCH AND STRUCTURAL TRADES.

MD4 REMOVE EXISTING PNEUMATIC THERMOSTAT AND ALL ASSOCIATED CONTROLS TUBING COMPLETE. PATCH AND PAINT WALL TO MATCH EXISTING CONSTRUCTION.

MECH DEMOLITION GENERAL NOTES

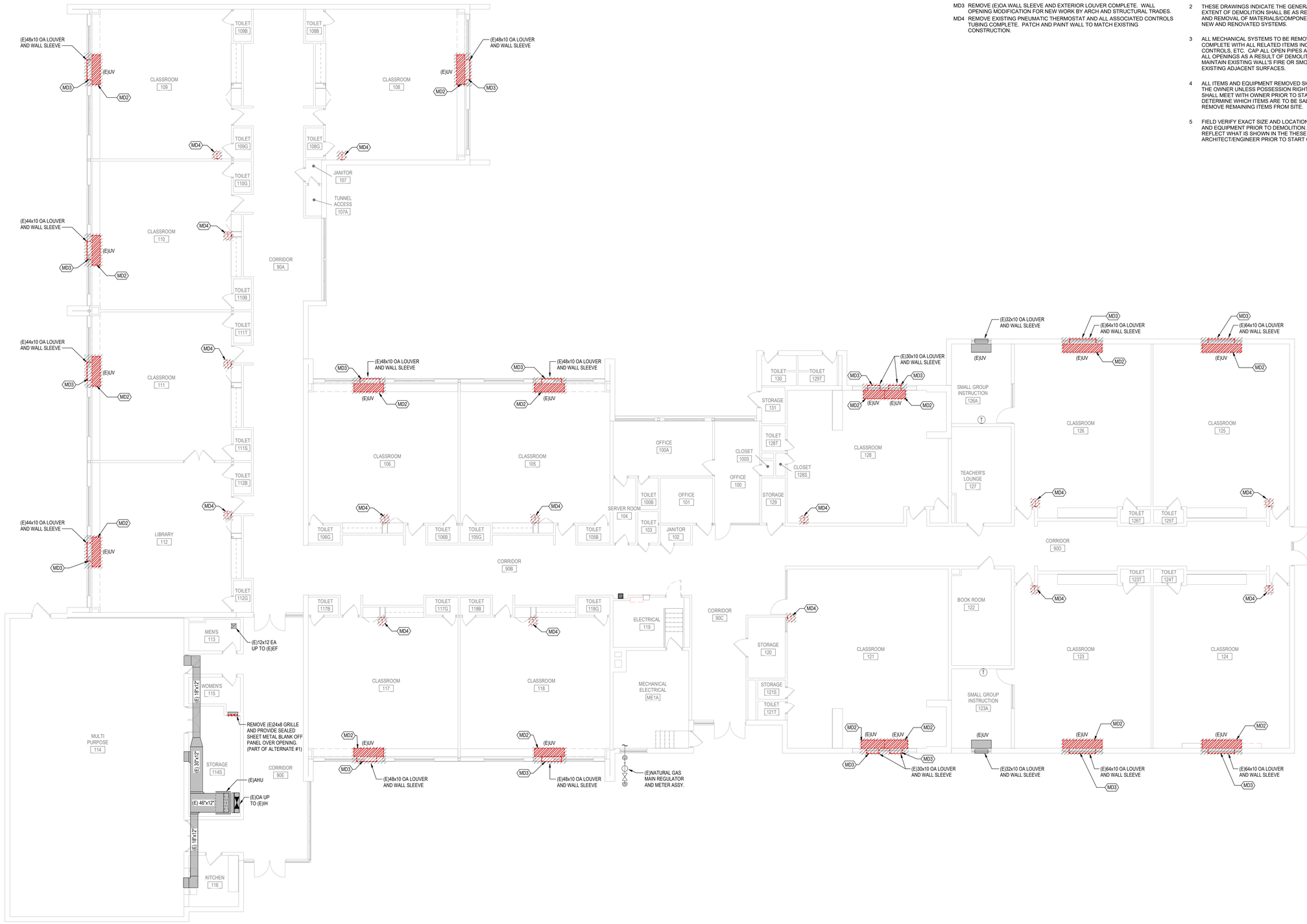
1 ANY INTERRUPTIONS OF EXISTING SERVICES OR EQUIPMENT SHALL BE PERFORMED AT A TIME APPROVED IN ADVANCE BY THE OWNER'S REPRESENTATIVE SO AS NOT TO INTERFERE WITH THE BUILDING OPERATION.

2 THESE DRAWINGS INDICATE THE GENERAL EXTENT OF WORK. THE EXTENT OF DEMOLITION SHALL BE AS REQUIRED BY THE NEW WORK AND REMOVAL OF MATERIALS/COMPONENTS NOT REQUIRED FOR THE NEW AND RENOVATED SYSTEMS.

3 ALL MECHANICAL SYSTEMS TO BE REMOVED SHALL BE REMOVED COMPLETE WITH ALL RELATED ITEMS INCLUDING HANGERS, SUPPORTS, CONTROLS, ETC. CAP ALL OPEN PIPES AND DUCTS. PATCH AND SEAL ALL OPENINGS AS A RESULT OF DEMOLITION IN RATED WALLS TO MAINTAIN EXISTING WALL'S FIRE OR SMOKE RATING AND TO MATCH EXISTING ADJACENT SURFACES.

4 ALL ITEMS AND EQUIPMENT REMOVED SHALL REMAIN PROPERTY OF THE OWNER UNLESS POSSESSION RIGHTS ARE WAIVED. CONTRACTOR SHALL MEET WITH OWNER PRIOR TO START OF DEMOLITION TO DETERMINE WHICH ITEMS ARE TO BE SALVAGED. CONTRACTOR SHALL REMOVE REMAINING ITEMS FROM SITE.

5 FIELD VERIFY EXACT SIZE AND LOCATION OF ALL EXISTING SERVICES AND EQUIPMENT PRIOR TO DEMOLITION. IF FIELD CONDITIONS DO NOT REFLECT WHAT IS SHOWN IN THE THESE DOCUMENTS, CONTACT ARCHITECT/ENGINEER PRIOR TO START OF DEMOLITION.



MECHANICAL DEMOLITION PLAN - FIRST LEVEL

1/8" = 1'-0"

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MECHANICAL DEMOLITION PLAN - FIRST LEVEL

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WHITE

MECHANICAL KEYNOTES

X

M01 EXTEND EXISTING STEAM AND STEAM CONDENSATE PIPING BRANCHES TO LOCATION OF NEW HORIZONTAL UNIT VENTILATOR FLOOR KNOCKOUTS FOR PIPE ENCLOSURE AND PENETRATE UP THROUGH FLOOR. CORE FLOOR AS REQUIRED TO ALIGN WITH ENCLOSURE. SEE DETAILS ON SHEET M501 FOR PENETRATION REQUIREMENTS.

MECHANICAL GENERAL NOTES

1 THESE DRAWINGS INDICATE THE GENERAL EXTENT OF WORK BUT ARE NOT FABRICATION DRAWINGS. COORDINATE HVAC PIPING SYSTEMS WITH WORK OF ALL OTHER TRADES PRIOR TO ANY FABRICATION OR INSTALLATION. PROVIDE ALL FITTINGS, OFFSETS, AND TRANSITIONS AS REQUIRED FOR A COMPLETE WORKABLE INSTALLATION.

2 PROVIDE ACCESS AROUND ALL NEW EQUIPMENT PER MANUFACTURERS RECOMMENDATIONS.

3 COORDINATE NEW DUCTWORK WITH SITE CONDITIONS EQUIPMENT MANUFACTURER AND ALL OTHER TRADES TO AVOID INTERFERENCES.

4 ALL DUCTWORK SHALL BE ROUTED AS HIGH AS POSSIBLE, UNLESS OTHERWISE NOTED. COORDINATE ROUTING WITH OTHER TRADES TO AVOID INTERFERENCES.

5 BALANCE ALL AIR SYSTEMS TO INDICATED AIR FLOW RATES.

6 DUCT SIZES TO DIFFUSERS SHALL MATCH NECK SIZE OF EACH. REFER TO GRILLE, REGISTER & DIFFUSER SCHEDULE.

7 REFER TO PIPING AND DUCT APPLICATION SCHEDULES FOR PIPING AND DUCTWORK INSULATION REQUIREMENTS.

8 ALL HVAC PIPING SHALL BE LABELED IN ACCORDANCE WITH THE REQUIREMENTS OF THE PROJECT SPECIFICATIONS.

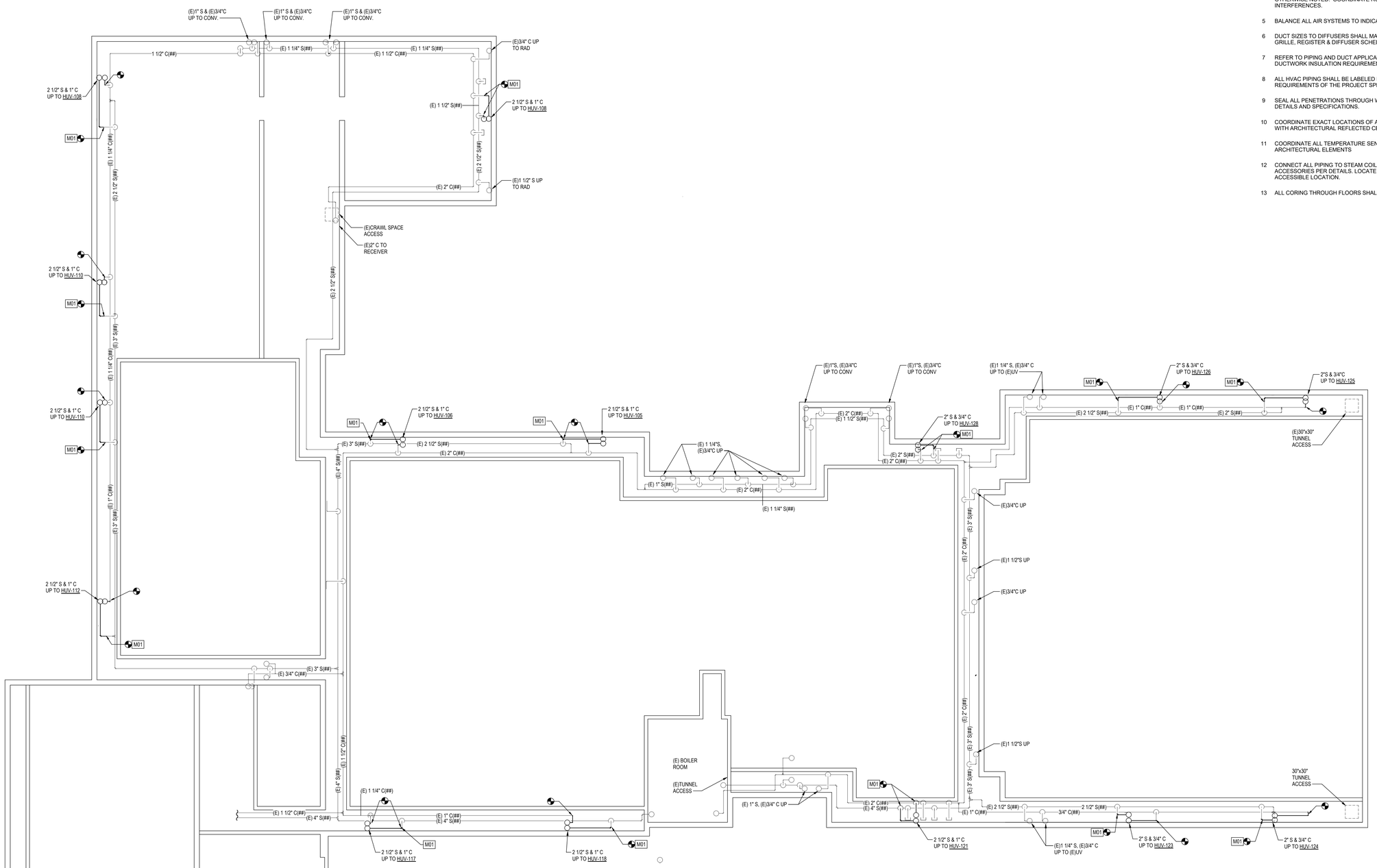
9 SEAL ALL PENETRATIONS THROUGH WALLS AIR AND WATERTIGHT PER DETAILS AND SPECIFICATIONS.

10 COORDINATE EXACT LOCATIONS OF ALL DIFFUSERS AND RETURN GRILLES WITH ARCHITECTURAL REFLECTED CEILING AND LIGHTING PLANS.

11 COORDINATE ALL TEMPERATURE SENSOR LOCATIONS WITH ARCHITECTURAL ELEMENTS

12 CONNECT ALL PIPING TO STEAM COILS AND PROVIDE ALL FITTINGS AND ACCESSORIES PER DETAILS. LOCATE ALL ISOLATION VALVES IN AN ACCESSIBLE LOCATION.

13 ALL CORING THROUGH FLOORS SHALL BE BY MECHANICAL CONTRACTOR.



MECHANICAL PLAN - TUNNEL LEVEL
1/8" = 1'-0"

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MECHANICAL PLAN - TUNNEL LEVEL

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WHITE

MECHANICAL KEYNOTES

X

M02 SEE STEAM COIL PIPING DETAIL ON SHEET M-501 FOR PIPING CONNECTIONS TO NEW HORIZONTAL UNIT VENTILATOR COIL AND REQUIRED ACCESSORIES. ROUTE 3/4" CONDENSATE DRAIN FROM MANUFACTURERS STUB INSIDE UNIT ENCLOSURE THROUGH EXTERIOR WALL AND TERMINATE 1" PAST WALL A MINIMUM OF 6" ABOVE GRADE.

M03 ROUTE NEW 7/8" SUCTION AND 3/8" LIQUID REFRIGERANT PIPING BETWEEN DX COIL WITHIN NEW HORIZONTAL UNIT VENTILATOR AND ROOF MOUNTED AIR COOLED CONDENSING UNIT. SEE ARCH PLANS FOR ENCLOSURE ROUTE BEHIND CASEWORK AS APPLICABLE. PROVIDE FORMED SHEET METAL ENCLOSURE (APPROXIMATELY 6"WX 3"D) TO ENCASE REFRIGERANT PIPING FOR EXTENT OF SHEET METAL RUN SHOWN ON PLANS TERMINATING AT CEILING OR SIDE-WALL AS SHOWN.

M04 PROVIDE NEW DDC THERMOSTAT IN LOCATION SHOWN. UTILIZE REFRIGERANT PIPING ENCLOSURE TO ROUTE WIRING FROM UNIT VENTILATOR TO FRONT OF CLASSROOM AND ROUTE WIREMOLD THE REMAINDER OF RUN BETWEEN REFRIGERANT PIPING SIDEWALL PENETRATION AND THERMOSTAT LOCATION. (IN ROOMS 123 THRU 126, ROUTE IN ENCLOSURE TO CEILING SPACE AND THEN ACROSS CEILING SPACE TO FRONT OF CLASSROOM AND DOWN IN WIREMOLD TO NEW THERMOSTAT LOCATION)

M05 INSTALL NEW HORIZONTAL UNIT VENTILATOR AT LOCATION SHOWN. SEE ARCHITECTURAL DETAILS FOR EXACT LOCATION. INSTALL MANUFACTURER FURNISHED ACCESSORIES INCLUDING END PANELS, BACK PLENUM, EXTERIOR WALL SLEEVE AND EXTERIOR LOUVER. WALL OPENING MODIFICATIONS BY ARCH TRADES.

M06 INSTALL MANUFACTURER PROVIDED RELIEF DAMPER SLEEVE ASSEMBLY AND EXTERIOR LOUVER. SLEEVE TO PENETRATE THROUGH TO EXTERIOR OF SIZE INDICATED MOUNTED AT 10'-4" A.F.F. WALL CUTTING/OPENING BY ARCH TRADES. SEE ARCH DETAIL.

M07 ROUTE 3/4" EVAPORATOR CONDENSATE DRAIN FROM WALL MOUNTED UNIT HORIZONTALLY TIGHT TO DECK THROUGH TOILET ROOM AND DOWN WALL WITHIN JANITOR ROOM TERMINATING 1'-0" ABOVE SERVICE SINK.

M08 ROUTE 1/4" LIQUID AND 1/2" SUCTION REFRIGERANT PIPING OVER DATA CONDUIT AND THROUGH WALL INTO CLASSROOM TIGHT TO DECK. ROUTE UP WALL WITHIN SHEET METAL ENCLOSURE AND ROUTE PARALLEL ENCLOSURES OUT TO ROOF.(UNDER HUV 105 REFRIGERANT ENCLOSURE). SEE DETAIL ON M501 FOR REQUIREMENTS.

MECHANICAL GENERAL NOTES

1 THESE DRAWINGS INDICATE THE GENERAL EXTENT OF WORK BUT ARE NOT FABRICATION DRAWINGS. COORDINATE HVAC PIPING SYSTEMS WITH WORK OF ALL OTHER TRADES PRIOR TO ANY FABRICATION OR INSTALLATION. PROVIDE ALL FITTINGS, OFFSETS, AND TRANSITIONS AS REQUIRED FOR A COMPLETE WORKABLE INSTALLATION.

2 PROVIDE ACCESS AROUND ALL NEW EQUIPMENT PER MANUFACTURERS RECOMMENDATIONS.

3 COORDINATE NEW DUCTWORK WITH SITE CONDITIONS EQUIPMENT MANUFACTURER AND ALL OTHER TRADES TO AVOID INTERFERENCES.

4 ALL DUCTWORK SHALL BE ROUTED AS HIGH AS POSSIBLE, UNLESS OTHERWISE NOTED. COORDINATE ROUTING WITH OTHER TRADES TO AVOID INTERFERENCES.

5 BALANCE ALL AIR SYSTEMS TO INDICATED AIR FLOW RATES.

6 DUCT SIZES TO DIFFUSERS SHALL MATCH NECK SIZE OF EACH. REFER TO GRILLE, REGISTER & DIFFUSER SCHEDULE.

7 REFER TO PIPING AND DUCT APPLICATION SCHEDULES FOR PIPING AND DUCTWORK INSULATION REQUIREMENTS.

8 ALL HVAC PIPING SHALL BE LABELED IN ACCORDANCE WITH THE REQUIREMENTS OF THE PROJECT SPECIFICATIONS.

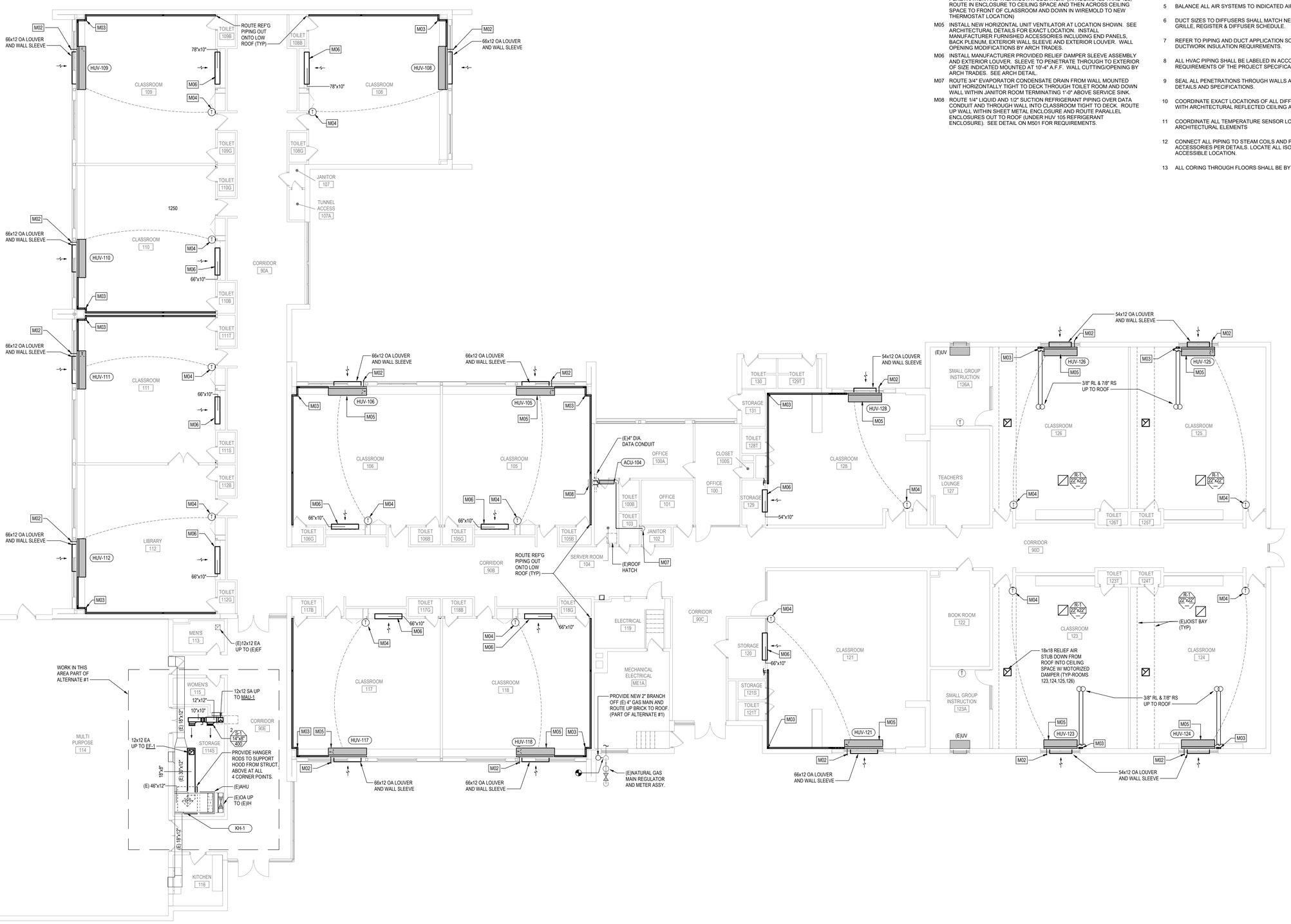
9 SEAL ALL PENETRATIONS THROUGH WALLS AIR AND WATERTIGHT PER DETAILS AND SPECIFICATIONS.

10 COORDINATE EXACT LOCATIONS OF ALL DIFFUSERS AND RETURN GRILLES WITH ARCHITECTURAL REFLECTED CEILING AND LIGHTING PLANS.

11 COORDINATE ALL TEMPERATURE SENSOR LOCATIONS WITH ARCHITECTURAL ELEMENTS

12 CONNECT ALL PIPING TO STEAM COILS AND PROVIDE ALL FITTINGS AND ACCESSORIES PER DETAILS. LOCATE ALL ISOLATION VALVES IN AN ACCESSIBLE LOCATION.

13 ALL CORING THROUGH FLOORS SHALL BE BY MECHANICAL CONTRACTOR.



MECHANICAL PLAN - FIRST LEVEL
1/8" = 1'-0"

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MECHANICAL PLAN - FIRST LEVEL

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DESIGNED BY: Designer
CHECKED BY: Checker APPROVED BY: Approver

WE RECYCLE
THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK
WHITE

MECHANICAL KEYNOTES

X

M09 MOUNT ACCU ON EQUIPMENT STAND. ROUTE 7/8" SUCTION AND 3/8" LIQUID REFRIGERANT LINES FROM ACCU DOWN THROUGH ROOF. PROVIDE PATE PIPE PORTAL FOR ROOF PENETRATION.

M10 MOUNT ACCU ON EQUIPMENT STAND. ROUTE 7/8" SUCTION AND 3/8" LIQUID REFRIGERANT LINES FROM ACCU ACROSS LOW ROOF THROUGH SIDE WALL INTO CLASSROOM.

MECHANICAL GENERAL NOTES

1 THESE DRAWINGS INDICATE THE GENERAL EXTENT OF WORK BUT ARE NOT FABRICATION DRAWINGS. COORDINATE HVAC PIPING SYSTEMS WITH WORK OF ALL OTHER TRADES PRIOR TO ANY FABRICATION OR INSTALLATION. PROVIDE ALL FITTINGS, OFFSETS, AND TRANSITIONS AS REQUIRED FOR A COMPLETE WORKABLE INSTALLATION.

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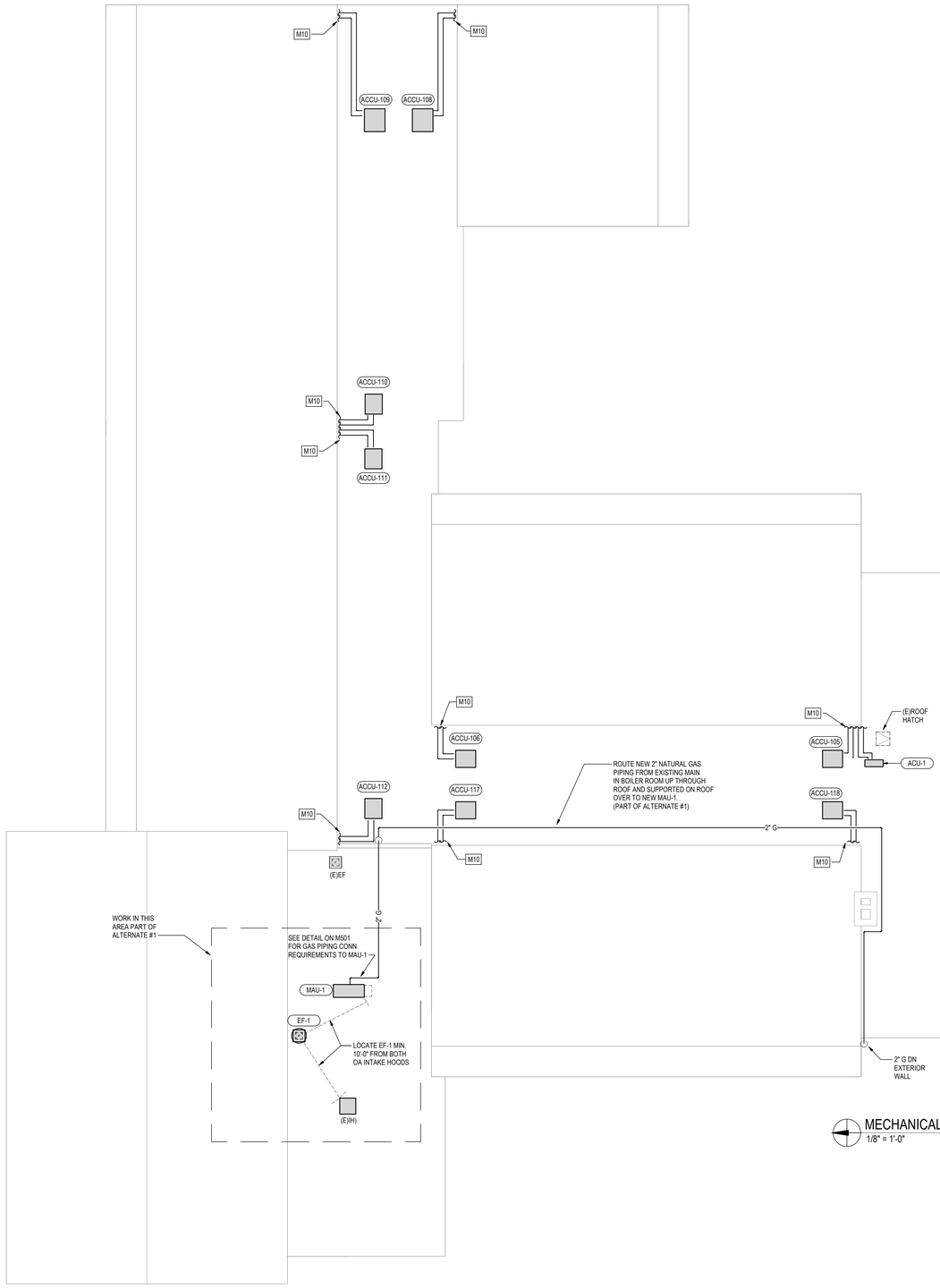

MECHANICAL PLAN - ROOF LEVEL
1/8" = 1'-0"

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MECHANICAL PLAN - ROOF LEVEL

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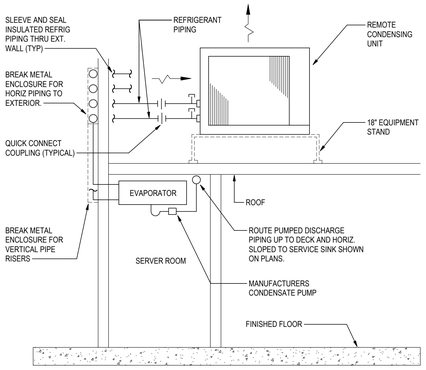
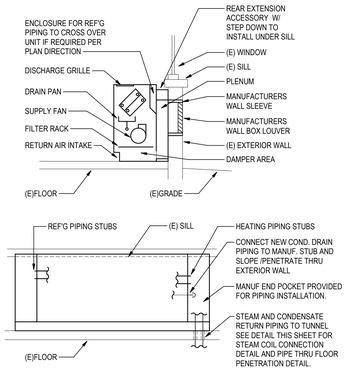
WHITE



NOTE:
1. INSTALL REFRIGERANT PIPING IN ACCORDANCE WITH MANUFACTURER'S REQUIREMENTS.

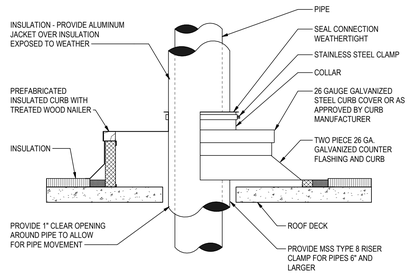
ACU-1 SPLIT SYSTEM EVAPORATOR AND REMOTE CONDENSING UNIT

SCALE: NONE



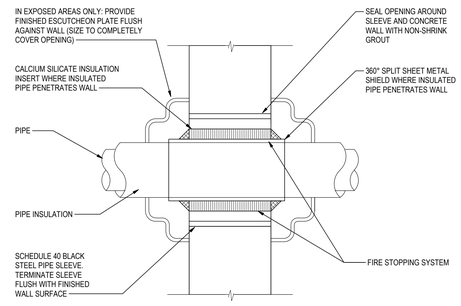
HORIZONTAL UNIT VENTILATOR DETAILS

SCALE: NONE



PIPE ROOF PENETRATION DETAIL

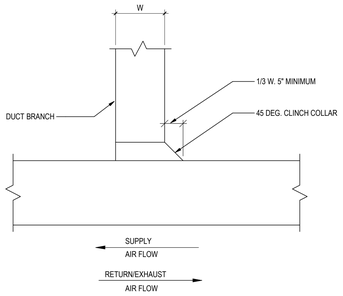
SCALE: NONE



NOTES:
1. DETAIL INDICATES THE INSULATION REQUIREMENTS FOR A FIRE RATED ASSEMBLY. FOR A NON-FIRE RATED ASSEMBLY PACK SLEEVED OPENING WITH INSULATION MATERIAL AND CAULK WITH NON-HARDENING SEALANT.
2. PIPE PENETRATION DETAIL SIMILAR FOR UNINSULATED PIPING.

POURED CONCRETE OR BLOCK WALL PIPE PENETRATION DETAIL

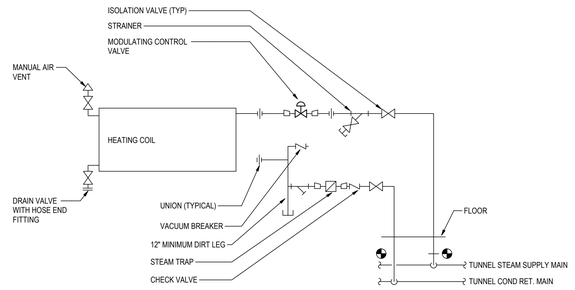
SCALE: NONE



NOTE:
1. FURNISH THIS TYPE CONNECTION FOR BRANCHES WITH LESS THAN 25% OF TOTAL AIR FLOW.

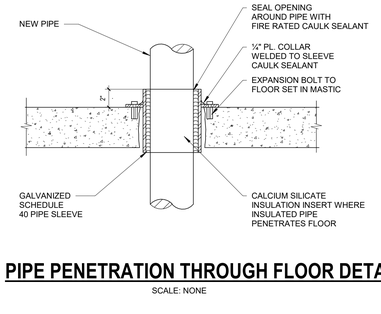
RECTANGULAR DUCT BRANCH CONNECTION DETAIL

SCALE: NONE



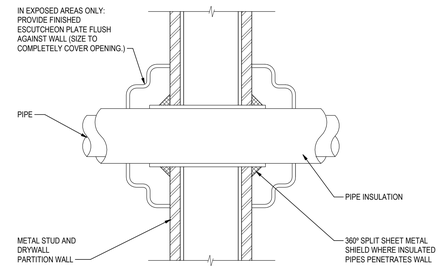
UNIT VENTILATOR STEAM HEATING COIL PIPING DIAGRAM

SCALE: NONE



PIPE PENETRATION THROUGH FLOOR DETAIL

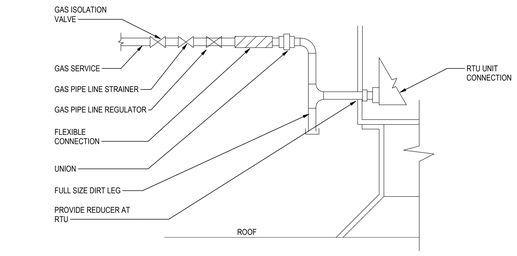
SCALE: NONE



NOTES:
1. PIPE PENETRATION DETAIL SIMILAR FOR UNINSULATED PIPING.

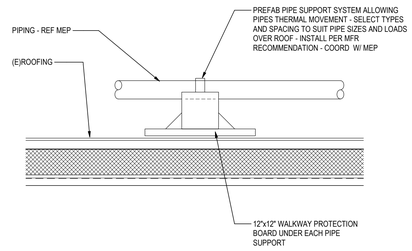
NON-FIRE RATED STUD AND DRYWALL PARTITION WALL PIPE PENETRATION DETAIL

SCALE: NONE



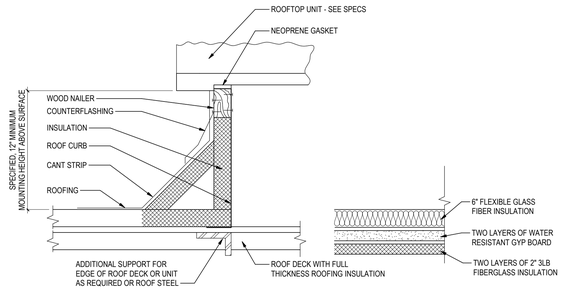
MAU-1 GAS PIPING DETAIL

SCALE: NONE



TYPICAL ROOF GAS PIPING SUPPORT DETAIL

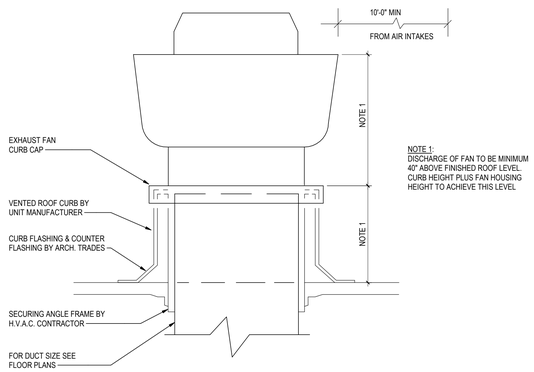
SCALE: NONE



MAU-1 ROOFTOP EQUIPMENT CURB DETAIL

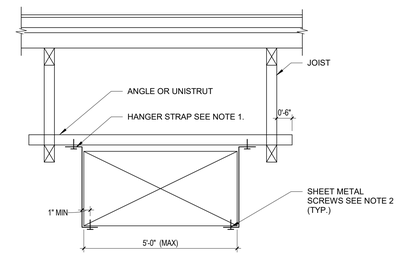
SCALE: NONE

NOTE:
ALL DUCT, PIPING, AND ELECTRICAL CONNECTIONS TO UNIT BELOW CURB SHALL HAVE FLEXIBLE CONNECTIONS. CUT INSULATION, GYP BOARD, ROOFING INSULATION, AND ROOF DECKING PENETRATIONS TIGHT TO ITEMS PENETRATING THROUGH THE ASSEMBLY. PACK ALL PENETRATION OPENINGS WITH FLEXIBLE INSULATION. PROVIDE SEALS AND GASKETS AT ALL ROOFTOP PENETRATIONS.

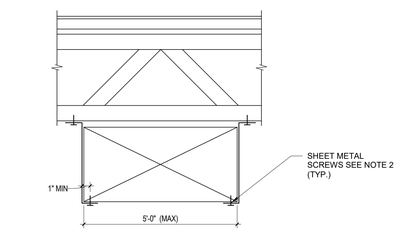


EXHAUST FAN DETAIL

SCALE: NONE



PARALLEL TO STRUCTURE



PERPENDICULAR TO STRUCTURE

NOTES:
1. USE THREADED ROD FOR ALL DUCTS LARGER THAN 60"ø WIDE
2. SHEET METAL SCREWS MAY BE OMITTED IT HANGER STRAP IS CONTINUOUS AND LOOPS UNDER ENTIRE DUCT

RECTANGULAR DUCT SUPPORT DETAIL

SCALE: NONE

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SPLIT SYSTEM AIR CONDITIONING UNIT SCHEDULE

UNIT IDENTIFICATION			PERFORMANCE			INDOOR UNIT													OUTDOOR UNIT												
														ELECTRICAL										ELECTRICAL						
MARK	NUMBER	ROOM(S) SERVED	EER	REFRIG TYPE	REFRIG CHARGE (LBS)	TOTAL CAPACITY (BTU/H)	SENSIBLE CAPACITY (BTU/H)	AIRFLOW (CFM)	EDB (F)	EWB (F)	LDB (F)	LWB (F)	MOUNTING	CONDENSATE PUMP REQUIRED	VOLTS	PHASE	MCA	MOP	OPERATING WEIGHT (LBS.)	MODEL NUMBER	NO. OF COMP	TYPE	AMBIENT DESIGN TEMP (F)	MINIMUM AMBIENT TEMP (F)	VOLTS	PHASE	MCA	MOP	OPERATING WEIGHT (LBS.)	MODEL NUMBER	MANUFACTURER	NOTES
ACU	1	SERVER - 104	9.9	R410A	5	18,000.0	N/A	425	80.0	67.0	55.0	55.0	WALL	YES	208	1	1.0	15	40	PKA-A18HA7	1	INVERTER ROTARY	95.0	-40.0	208	1	11.0	28	120	PUY-A18NKA7	MITSUBISHI ELECTRIC	1,2,3,4,5

NOTES:
1. PROVIDE ALL INTERCONNECTING WIRING BETWEEN THE INDOOR AND OUTDOOR UNITS.
2. OUTDOOR UNIT TO BE MOUNTED ON 18" ROOF EQUIPMENT STAND QSMS1801M BY DIVERSITECH OR EQUAL BY MIRO OR RECTOR SEAL.
3. SPEED BASED ON HIGH SPEED.
4. PROVIDE WITH DISCONNECT SWITCH.
5. PROVIDE OUTDOOR UNIT WITH HAIL GUARDS, AND WIND BAFFLES REQUIRED TO MEET LOW AMBIENT LISTED IN SCHEDULE.

DUCT SYSTEM APPLICATION SCHEDULE

SYSTEM	APPLICATION	LOCATION	DESIGN CRITERIA		CONSTRUCTION			PRODUCT			MATERIAL							LINER					INSULATION						FACTORY JACKET				FIELD JACKET					NOTES
			MAX VELOCITY (FPM)	MAX FRICTION (IN-WG/100')	DESIGN SYSTEM PRESSURE (IN-WG)	SEAL CLASS	MAX LEAKAGE RATE	SINGLE WALL	DOUBLE WALL SOLID LINER	DOUBLE WALL PERF LINER	G90 GALV SHEET STEEL	G90 PVC COATED GALV SHEET STEEL	16 GA CARBON STEEL	ALUMINUM	304 STAINLESS STEEL	316 STAINLESS STEEL	FABRIC	FIBERGLASS	FLEXIBLE ELASTOMERIC	NATURAL FIBER	THICKNESS (IN)	DENSITY (LB/FT³)	FIBERGLASS BLANKET	FIBERGLASS BOARD	FLEXIBLE ELASTOMERIC	FIRE RATED WRAP	FIRE RATED BOARD	THICKNESS (IN)	DENSITY (LB/FT³)	ASJ	ASJ-SS	FSK	VINYL	FABRIC	PVC	ALUMINUM	STAINLESS STEEL	SELF ADHESIVE	
SUPPLY AIR	LOW PRESSURE (CONSTANT VOLUME)	CONCEALED	1,000	0.10	2	A	6	X			X												X					1.5	1			X						
		EXPOSED	1,000	0.10	2	A	6	X			X													X				1	2.25	X								
TYPE II HOOD EXHAUST	ALL	CONCEALED	1,000	0.10	2	A	6	X			X																											
		EXPOSED	1,000	0.10	2	A	6	X			X																											
RELIEF AIR	ALL	ALL	1,000	0.10	2	B	6	X			X												X					1.5	1			X						

NOTES:

PIPING SYSTEM APPLICATION SCHEDULE

SYSTEM	PIPE SIZE (IN)	DESIGN		CONSTRUCTION					LOCATION	MATERIAL						JOINTS					INSULATION		FACTORY JACKET				FIELD JACKET					NOTES
		MAX VELOCITY (FPS)	MAX FRICTION (FT/100')	OPERATING PRESS	MIN WORKING PRESSURE (PSIG)	MIN TEMP RATING (F)	TEST PRESSURE (PSIG)	TES DURATION (HRS)		COPPER TYPE K	COPPER TYPE L	SCH 40 STEEL	SCH 80 STEEL	SCH 10 TYPE 316 STAINLESS STEEL	SCH 10 TYPE 304 STAINLESS STEEL	PEX-A	SOLDERED	BRAZED	THREATED	WELDED	PRESSURE FITTINGS	GROOVED	MINERAL FIBER, PREFORMED	FLEXIBLE ELASTOMERIC	THICKNESS (IN)	ASJ	ASJ-SS	FSK	VINYL	PVC - ALL	PVC - FITTINGS	PVC - TO 10 FEET AFF	ALUMINUM	STAINLESS STEEL	
LOW PRESSURE STEAM	2 AND LESS	4,000	N/A	15#	125	325	125	2.5	CONCEALED			X							X				X		3		X				X				
									EXPOSED			X							X				X		3		X				X	X			
									TUNNEL			X							X				X		3		X				X				
	2-1/2 AND LARGER	8,000	N/A	15#	125	250	125	2.5	CONCEALED			X								X			X		4		X				X				
									EXPOSED			X								X			X		4		X				X	X			
									TUNNEL			X								X			X		4		X				X				
LOW PRESSURE CONDENSATE AND PUMPED CONDENSATE	2 AND LESS	4,000	N/A	15#	125	250	125	2.5	CONCEALED				X						X				X		3		X				X				
									EXPOSED				X						X				X		3		X				X	X			
									TUNNEL				X						X				X		3		X				X				
	2-1/2 AND LARGER	8,000	N/A	15#	125	250	125	2.5	CONCEALED				X							X			X		4		X				X				
									EXPOSED				X							X			X		4		X				X	X			
									TUNNEL				X							X			X		4		X				X				

NOTES:
1. PIPE INSULATION THICKNESS BASED ON ASHRAE 90.1-2013.

GRILLE, REGISTER, DIFFUSER SCHEDULE

UNIT IDENTIFICATION		DIFFUSER FACE SIZE (IN)	FLOW RANGE (CFM)	DIFFUSER NECK SIZE (IN)	FLOW PATTERN	MOUNTING TYPE	COLOR	MATERIAL	ACCESSORY	MANUFACTURER	MODEL NUMBER	NOTES
MARK	NUMBER											
S	1	SEE PLANS	SEE PLANS	SEE PLANS	DOUBLE DEFL.	SIDE-WALL	WHITE	STEEL	NONE	PRICE	520L	1
R	1	24x24	SEE PLANS	-	-	LAY-IN	WHITE	STEEL	NONE	PRICE	80	1

NOTES:
1. PROVIDE ALL FRAMES AND ACCESSORIES AS REQUIRED FOR PROPER INSTALLATION.

RELIEF HOOD SCHEDULE

UNIT IDENTIFICATION			AIRFLOW (CFM)	STATIC PRESSURE (IN-WG)	ROOF CURB HEIGHT (IN)	THROAT			HOOD					MANUFACTURER	MODEL NUMBER	NOTES
MARK	NUMBER	UNIT/ AREA SERVED				WIDTH (IN)	LENGTH (IN)	THROAT VELOCITY (FPM)	MATERIAL	WIDTH (IN)	LENGTH (IN)	HEIGHT (IN)	OPERATING WEIGHT (LBS.)			
GRH	123	HUV-123	1,000	0.05	18	18	18	444	GALV STEEL	28	36	16	200	GREENHECK	FGR	1
GRH	124	HUV-124	1,000	0.05	18	18	18	444	GALV STEEL	28	36	16	200	GREENHECK	FGR	1
GRH	125	HUV-125	1,000	0.05	18	18	18	444	GALV STEEL	28	36	16	200	GREENHECK	FGR	1
GRH	126	HUV-126	1,000	0.05	18	18	18	444	GALV STEEL	28	36	16	200	GREENHECK	FGR	1

NOTES:
1.PROVIDE WITH BACKDRAFT DAMPER.

THIS EQUIPMENT IS PART OF ALTERNATE #1

MAKEUP AIR UNIT SCHEDULE

UNIT IDENTIFICATION				FAN						GAS BURNER								PHYSICAL CHARACTERISTICS				ELECTRICAL							NOTES
MARK	NUMBER	ROOM(S) SERVED	DESIGN (CFM)	MIN AIRFLOW (CFM)	ESP (IN-WG)	SPEED (RPM)	BHP	HP	CONTROL	EDB (F)	LDB (F)	FUEL TYPE	PRESSURE RANGE (IN-WG)	FIRING RATE INPUT (MBH)	FIRING RATE OUTPUT (MBH)	BURNER CONTROL	MIN TURN DOWN	WEIGHT (LBS)	HEIGHT (IN)	WIDTH (IN)	LENGTH (IN)	VOLTS	PHASE	FLA	MCA	MOP	MANUFACTURER	MODEL NUMBER	
MAU	1	114 - STORAGE	800	600	0.5	1,603	0.34	1	ECM 0-10 VDC	0.0	80.0	NAT. GAS	7 - 14	71.0	65.3	MODULATING	10:1	500	22	22	54	115	1	12	17	25	CAPTIVE-AIRE	D76	1,2,3,4

NOTES:
1. UNIT TO BE MOUNTED ON 18" ROOF CURB.
2. PROVIDE WITH OA INTAKE HOOD, FILTERS, AND MOTORIZED INTAKE DAMPER.
3. PROVIDE WITH EXHAUST CONTACTOR BEFORE AIRFLOW SWITCH. TO BE FIELD WIRED.
4. PROVIDE WITH ECM WIRING PACKAGE W/ 0-10 VDC CONTROL.

POWER VENTILATOR SCHEDULE

UNIT IDENTIFICATION			AIRFLOW (CFM)	ESP (IN-WG)	CONTROL	FAN WHEEL			FAN MOTOR				VENTED CURB HEIGHT (IN)	ELECTRICAL			OPERATING WEIGHT (LBS.)	MANUFACTURER	MODEL NUMBER	NOTES
MARK	NUMBER	AREA SERVED				TYPE	SPEED (RPM)	MIN WHEEL DIA (IN)	BHP	HP	SPEED (RPM)	DRIVE TYPE		VOLTS	PHASE	FLA				
EF	1	STORAGE - 114 (KH-1)	800	0.5	HEAT SENSOR	UPBLAST	1,421	N/A	0.17	1/3	1,725	DIRECT	22" MIN	115	1	4.3	100	CAPTIVE-AIRE	DU33HFA	1,2,3,4

NOTES:
1. PROVIDE WITH 22" VENTED CURB FOR DISCHARGE AT 40° ABOVE ROOF.
2. PROVIDE HINGED CONNECTION FROM FAN HOUSING TO CURB.
3. PROVIDE WITH VARIABLE SPEED EC MOTOR.
4. PROVIDE WITH INTEGRAL NEMA 3R DISCONNECT SWITCH.

KITCHEN HOOD SCHEDULE

UNIT IDENTIFICATION			TYPE	AIRFLOW (CFM)	STATIC PRESSURE (IN-WG)	PHYSICAL CHARACTERISTICS				COLLAR SIZE (IN)	MATERIAL	MANUFACTURER	MODEL NUMBER	NOTES
MARK	NUMBER	LOCATION				LENGTH (IN)	DEPTH (IN)	HEIGHT (IN)	WEIGHT (LBS)					
KH	1	114 - STORAGE	2	800	-0.12	48	66	24	400	12 ROUND	430 SS	CAPTIVE-AIRE	6624 VHB-G-PSP-F	1,2,3,4

NOTES:
1.PROVIDE WITH 18" FIELD WRAPPER ON FRONT, LEFT AND RIGHT.
2.PROVIDE 430SS 80"Hx48"W BACKSPLASH.
3.PROVIDE WITH RIGHT AND LEFT VERTICAL 430 SS END PANELS.
4.PROVIDE WITH LIGHT.

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WHITE

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MECHANICAL SCHEDULES

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 214100605
DATE: 11-NOV-2022
SHEET
M-601

CONSTRUCTION DOCUMENTS

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DESIGNED BY: Designer
CHECKED BY: Checker APPROVED BY: Approver

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WHITE

HORIZONTAL UNIT VENTILATOR SCHEDULE

UNIT IDENTIFICATION				SUPPLY FAN					DX COOLING COIL						STEAM HEATING COIL				FILTER			PHYSICAL CHARACTERISTICS					ELECTRICAL						
MARK	NUMBER	ROOM SERVED	NOMINAL TONS	AIRFLOW (CFM)	DESIGN OUTSIDE AIR (CFM)	MIN OUTSIDE AIR (CFM)	QTY	HP	TOTAL CAPACITY (MBH)	SENSIBLE CAPACITY (MBH)	EDB (F)	EWB (F)	LDB (F)	LWB (F)	TOTAL CAPACITY (MBH)	EDB (F)	LDB (F)	INLET PRESSURE (PSIG)	TYPE	EFF (MERV)	NO OF FILTERS	HEIGHT (IN)	WIDTH (IN)	DEPTH (IN)	OPERATING WEIGHT (LBS.)	ACCESSORY OA LOUVER SIZE (WXH)	REMOTE RELIEF AIR DMPR SIZE (WxH)	VOLTS	PHASE	MCA	FUSE SIZE	MANUFACTURER	MODEL NUMBER	NOTES
HUV	105	CLASSROOM - 105	4	1,230	350	200	4	1/3	43.4	32.6	80.0	67.0	55.6	55.5	67.2	50.1	100.5	2.0	DISPOSABLE	13	1	30	86	22	550	66x12	66x12	115	1	6.3	15	TRANE	VUVE12500Z	1,2,3,4,5,7,8,9
HUV	106	CLASSROOM - 106	4	1,230	350	200	4	1/3	43.4	32.6	80.0	67.0	55.6	55.5	67.2	50.1	100.5	2.0	DISPOSABLE	13	1	30	86	22	550	66x12	66x12	115	1	6.3	15	TRANE	VUVE12500Z	1,2,3,4,5,7,8,9
HUV	108	CLASSROOM - 108	5	1,475	350	225	4	1/3	53.7	40.3	80.0	67.0	54.8	54.8	82.4	54.0	105.5	2.0	DISPOSABLE	13	1	30	98	22	600	78x12	78x12	115	1	6.3	15	TRANE	VUVE15000Z	1,2,3,4,5,7,8,9
HUV	109	CLASSROOM - 109	5	1,475	350	225	4	1/3	53.7	40.3	80.0	67.0	54.8	54.8	82.4	54.0	105.5	2.0	DISPOSABLE	13	1	30	98	22	600	78x12	78x12	115	1	6.3	15	TRANE	VUVE15000Z	1,2,3,4,5,7,8,9
HUV	110	CLASSROOM - 110	4	1,230	350	200	4	1/3	43.4	32.6	80.0	67.0	55.6	55.5	67.2	50.1	100.5	2.0	DISPOSABLE	13	1	30	86	22	550	66x12	66x12	115	1	6.3	15	TRANE	VUVE12500Z	1,2,3,4,5,7,8,9
HUV	111	CLASSROOM - 111	4	1,230	350	200	4	1/3	43.4	32.6	80.0	67.0	55.6	55.5	67.2	50.1	100.5	2.0	DISPOSABLE	13	1	30	86	22	550	66x12	66x12	115	1	6.3	15	TRANE	VUVE12500Z	1,2,3,4,5,7,8,9
HUV	112	CLASSROOM - 112	4	1,230	350	200	4	1/3	43.4	32.6	80.0	67.0	55.6	55.5	67.2	50.1	100.5	2.0	DISPOSABLE	13	1	30	86	22	550	66x12	66x12	115	1	6.3	15	TRANE	VUVE12500Z	1,2,3,4,5,7,8,9
HUV	117	CLASSROOM - 117	4	1,230	350	200	4	1/3	43.4	32.6	80.0	67.0	55.6	55.5	67.2	50.1	100.5	2.0	DISPOSABLE	13	1	30	86	22	550	66x12	66x12	115	1	6.3	15	TRANE	VUVE12500Z	1,2,3,4,5,7,8,9
HUV	118	CLASSROOM - 118	4	1,230	350	200	4	1/3	43.4	32.6	80.0	67.0	55.6	55.5	67.2	50.1	100.5	2.0	DISPOSABLE	13	1	30	86	22	550	66x12	66x12	115	1	6.3	15	TRANE	VUVE12500Z	1,2,3,4,5,7,8,9
HUV	121	CLASSROOM - 121	4	1,230	475	200	4	1/3	43.4	32.6	80.0	67.0	55.6	55.5	67.2	50.1	100.5	2.0	DISPOSABLE	13	1	30	86	22	550	66x12	66x12	115	1	6.3	15	TRANE	VUVE12500Z	1,2,3,4,5,6,8,9
HUV	123	CLASSROOM - 123	3	1,000	380	150	3	1/3	33.2	24.9	80.0	67.0	57.1	56.3	54.1	44.6	99.8	2.0	DISPOSABLE	13	1	30	74	22	500	54x12	54x12	115	1	6.3	15	TRANE	VUVE10000	1,2,3,4,6,8,9
HUV	124	CLASSROOM - 124	3	1,000	380	150	3	1/3	33.2	24.9	80.0	67.0	57.1	56.3	54.1	44.6	99.8	2.0	DISPOSABLE	13	1	30	74	22	500	54x12	54x12	115	1	6.3	15	TRANE	VUVE10000	1,2,3,4,6,8,9
HUV	125	CLASSROOM - 125	3	1,000	380	150	3	1/3	33.2	24.9	80.0	67.0	57.1	56.3	54.1	44.6	99.8	2.0	DISPOSABLE	13	1	30	74	22	500	54x12	54x12	115	1	6.3	15	TRANE	VUVE10000	1,2,3,4,6,8,9
HUV	126	CLASSROOM - 126	3	1,000	380	150	3	1/3	33.2	24.9	80.0	67.0	57.1	56.3	54.1	44.6	99.8	2.0	DISPOSABLE	13	1	30	74	22	500	54x12	54x12	115	1	6.3	15	TRANE	VUVE10000	1,2,3,4,6,8,9
HUV	128	CLASSROOM - 128	3	1,000	350	150	3	1/3	33.2	24.9	80.0	67.0	57.1	56.3	54.1	44.0	99.6	2.0	DISPOSABLE	13	1	30	74	22	500	54x12	54x12	115	1	6.3	15	TRANE	VUVE10000	1,2,3,4,5,6,8,9

NOTES:
1.PROVIDE UNIT WITH 1" DISPOSABLE MERV 13 FILTERS.
2.PROVIDE UNIT WITH DIGITAL READY CONTROLS.
3.PROVIDE WITH EXTERIOR WALL SLEEVE. (CUSTOM HEIGHT TO MATCH LOUVER HEIGHT)
4.PROVIDE WITH PAINTED EXTERIOR LOUVER WITH BIRDSCREEN (12" CUSTOM HEIGHT).
5.PROVIDE WITH REMOTE RELIEF AIR DAMPER AND WALL BOX LOUVER.
6.PROVIDE WITH INSULATED FULL ADAPTER BACK WITH 2" STEPDOWN.
7.PROVIDE WITH INSULATED FULL ADAPTER BACK.
8.PROVIDE WITH END PANELS AND KNOCKOUTS FOR PIPING THROUGH FLOOR AND SIDES.
9.SUPPLY UNIT WITH CONTROL VALVE WITH DDC ACTUATOR FOR PIPING BY MC.

** ALL HUV'S ARE BEING FURNISHED THROUGH AN EARLY EQUIPMENT PACKAGE. ALL FURNISHED UNITS AND ACCESSORIES LISTED HERE ARE TO BE INSTALLED BY THE MECHANICAL CONTRACTOR THROUGH THIS BID PACK. **

AIR COOLED CONDENSING UNIT SCHEDULE

UNIT IDENTIFICATION					COMPRESSORS				CONDENSER FAN		PHYSICAL CHARACTERISTICS				ELECTRICAL						
MARK	NUMBER	UNIT SERVED	CAPACITY (MBH)	EER	TYPE	NO OF CIRCUITS	NO OF STAGES	REFRIG TYPE	NO OF FANS	HP (EACH)	HEIGHT (IN)	WIDTH (IN)	LENGTH (IN)	OPERATING WEIGHT (LBS)	VOLTS	PHASE	MCA	MOP	MANUFACTURER	MODEL NUMBER	NOTES
ACCU	105	HUV-105	48.0	11.0	SCROLL	1	2	410A	1	N/A	39	35	30	275	208	3	20.3	30	LENNOX	SSB048H4-230	
ACCU	106	HUV-106	48.0	11.0	SCROLL	1	2	410A	1	N/A	39	35	30	200	208	3	20.3	30	LENNOX	SSB048H4-230	
ACCU	108	HUV-108	60.0	11.0	SCROLL	1	2	410A	1	N/A	45	40	36	340	208	3	22.4	35	LENNOX	SSB060H4-230	
ACCU	109	HUV-109	60.0	11.0	SCROLL	1	2	410A	1	N/A	45	40	36	340	208	3	22.4	35	LENNOX	SSB060H4-230	
ACCU	110	HUV-110	48.0	11.0	SCROLL	1	2	410A	1	N/A	39	35	30	275	208	3	20.3	30	LENNOX	SSB048H4-230	
ACCU	111	HUV-111	48.0	11.0	SCROLL	1	2	410A	1	N/A	39	35	30	275	208	3	20.3	30	LENNOX	SSB048H4-230	
ACCU	112	HUV-112	48.0	11.0	SCROLL	1	2	410A	1	N/A	39	35	30	275	208	3	20.3	30	LENNOX	SSB048H4-230	
ACCU	117	HUV-117	48.0	11.0	SCROLL	1	2	410A	1	N/A	39	35	30	275	208	3	20.3	30	LENNOX	SSB048H4-230	
ACCU	118	HUV-118	48.0	11.0	SCROLL	1	2	410A	1	N/A	39	35	30	275	208	3	20.3	30	LENNOX	SSB048H4-230	
ACCU	121	HUV-121	48.0	11.0	SCROLL	1	2	410A	1	N/A	39	35	30	275	208	3	20.3	30	LENNOX	SSB048H4-230	
ACCU	123	HUV-123	36.0	11.0	SCROLL	1	2	410A	1	N/A	35	31	31	250	208	3	16.2	25	LENNOX	SSB036H4-230	
ACCU	124	HUV-124	36.0	11.0	SCROLL	1	2	410A	1	N/A	35	31	31	250	208	3	16.2	25	LENNOX	SSB036H4-230	
ACCU	125	HUV-125	36.0	11.0	SCROLL	1	2	410A	1	N/A	35	31	31	250	208	3	16.2	25	LENNOX	SSB036H4-230	
ACCU	126	HUV-126	36.0	11.0	SCROLL	1	2	410A	1	N/A	35	31	31	250	208	3	16.2	25	LENNOX	SSB036H4-230	
ACCU	128	HUV-128	36.0	11.0	SCROLL	1	2	410A	1	N/A	35	31	31	250	208	3	16.2	25	LENNOX	SSB036H4-230	

** ALL ACCU'S ARE BEING FURNISHED THROUGH AN EARLY EQUIPMENT PACKAGE. ALL FURNISHED UNITS LISTED HERE ARE TO BE INSTALLED BY THE MECHANICAL CONTRACTOR THROUGH THIS BID PACK. **

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MECHANICAL SCHEDULES

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REV	DESCRIPTION	DATE

PROJ. #: 214100605
DATE: 11-NOV-2022
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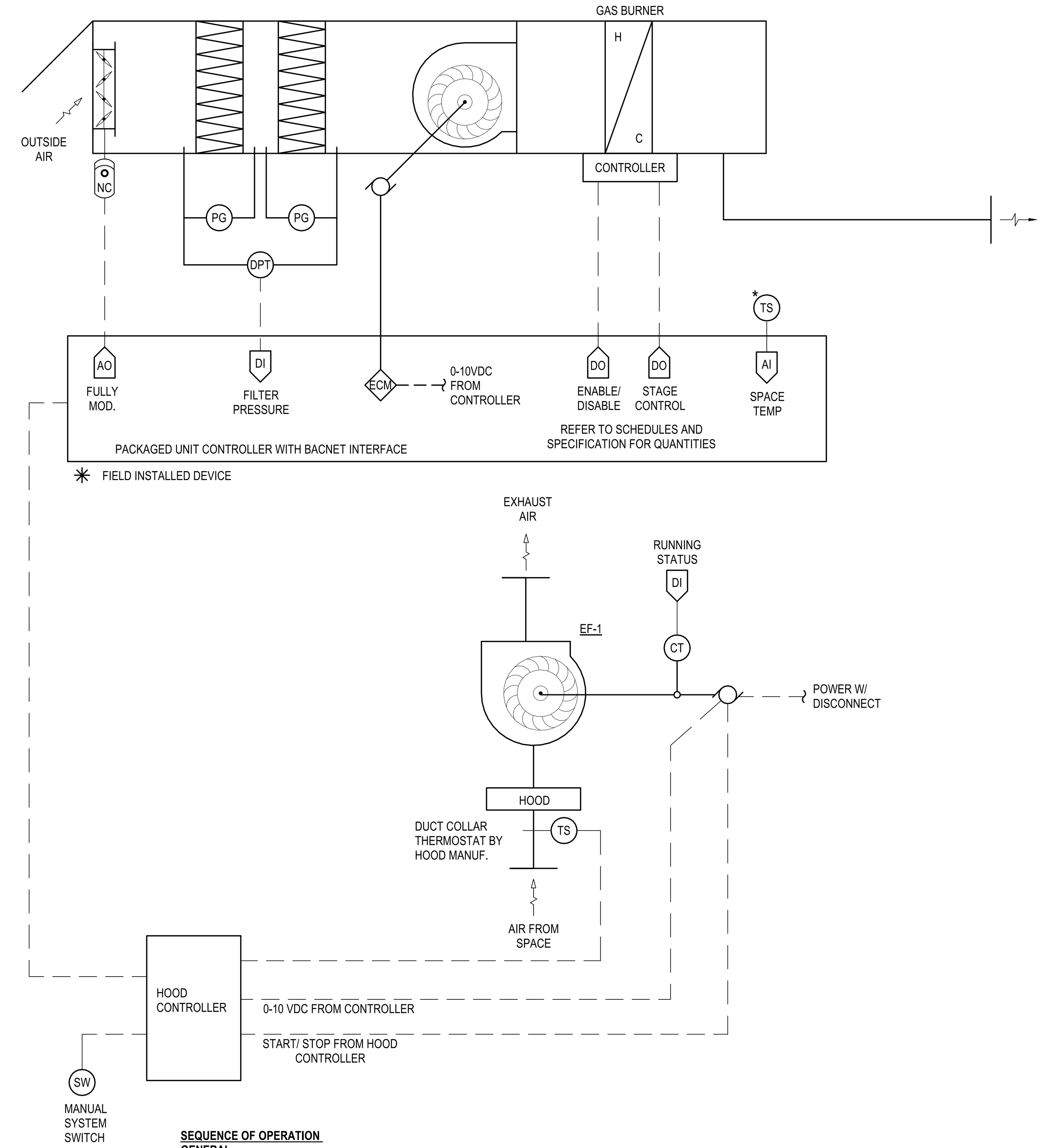
CONSTRUCTION DOCUMENTS



SEQUENCE OF OPERATION

GENERAL

1 THE UNIT WILL BE PROVIDED WITH PACKAGED DDC CONTROLS PROGRAMMED TO THE SEQUENCE OF OPERATION DESCRIBED WITHIN THE CONTRACT DOCUMENTS. PROVIDE AND INSTALL ALL NECESSARY COMPONENTS AND ACCESSORIES FOR A COMPLETE AND OPERATIONAL SYSTEM INCLUDING, BUT NOT LIMITED TO SENSORS, RELAYS, GATEWAYS, COMMUNICATION WIRING AND CONDUIT, AND ALL NECESSARY ELECTRICAL DEVICES, WIRING, AND CONDUIT.

2 ALL FIELD WIRED OR INSTALLED DEVICES WILL BE PROCURRED AND INSTALLED BY THE CONTRACTOR. DEVICES MAY BE PROVIDED BY UNIT MANUFACTURER. CONTRACTOR SHALL COORDINATE AND PROVIDE ALL ADDITIONAL COMPONENTS OR LABOR FOR A COMPLETE AND OPERATIONAL SYSTEM COMPLYING WITH THE OPERATING INTENT OF THE DOCUMENTS.

3 ALL POINTS IDENTIFIED IN THE CONSTRUCTION DOCUMENTS WILL BE DISPLAYED ON THE USER'S GRAPHIC INTERFACE. ALARMS AND OTHER SYSTEM NOTIFICATIONS WILL BE REPORTED TO SYSTEM USERS. PROVIDE ALL NECESSARY INTEGRATION FROM PACKAGED CONTROLLER TO FACILITY CONTROL SYSTEM.

4 ALL HAND-OFF-AUTO (HOA) SWITCHES NORMALLY REMAIN IN THE AUTO POSITION AND THE HAND AND OFF POSITIONS ARE USED FOR MAINTENANCE SITUATIONS. ALL SET POINTS, DEAD BANDS, AND TIME DELAY INTERVALS DESCRIBED IN SEQUENCE SHALL BE ADJUSTABLE BY SYSTEM OPERATORS. APPROPRIATE DEAD BANDS AND TIME DELAYS SHALL BE USED TO PREVENT SHORT CYCLING SITUATIONS.

SCHEDULING

1 THE KITCHEN SYSTEM RUNS CONTINUOUSLY DURING THE OPERATIONAL MODE UNLESS DEACTIVATED FOR MAINTENANCE, SCHEDULED SHUTDOWNS, OR A SAFETY TRIP.

2 THE KITCHEN SYSTEM SHALL HAVE SCHEDULING FUNCTIONALITY THROUGH THE DDC SYSTEM OR MAY OPERATE LOCALLY. SCHEDULE TO BE PROGRAMMED DURING SYSTEM COMMISSIONING OR OWNER TRAINING. CONTRACTOR TO SET UP SCHEDULES WITH OWNER'S PERSONNEL.

OPERATION

1 THE MAKE UP AIR UNIT AND EXHAUST FAN WILL ENERGIZE WHENEVER LOCALLY COMMANDED TO OPERATE OR WHEN THE TEMPERATURE SENSOR IN THE DUCT IS ACTIVE OR WHEN COMMANDED REMOTELY FROM THE DDC SYSTEM.

2 UPON A CALL TO START, THE SYSTEM OPENS ALL DAMPERS AND AFTER A DELAY, THE SYSTEM MODULATES THE EXHAUST FAN EC MOTOR AND THE MAKE UP AIR UNIT FANS TO THEIR RESPECTIVE SET POINTS DETERMINED DURING SYSTEM BALANCING TO ACHIEVE SCHEDULED AIRFLOW.

3 UPON ACTIVATION OF THE FIRE ALARM SYSTEM, THE EXHAUST FAN CONTINUES TO RUN AND THE MAKE UP AIR UNIT DEACTIVATES.

TEMPERATURE CONTROL

1 THE MAKE UP AIR UNIT PACKAGE CONTROLLER MODULATES AND STAGES THE GAS HEATING SYSTEM TO MAINTAIN THE SPACE TEMPERATURE SETPOINT.

FILTER MONITORING

1 THE PACKAGED CONTROL SYSTEM MONITORS FILTER STATIC AND UPON REACHING SET POINT, THE PACKAGED CONTROL SYSTEM SENDS A SIGNAL TO THE DDC SYSTEM INDICATING A DIRTY FILTER.

SAFETY CONTROL

1 IF SMOKE IS DETECTED IN THE AIRSTREAM BY A DUCT SMOKE DETECTOR OR THE FIRE ALARM ZONE MODULE INDICATES A ZONE ALARM, THE UNIT SHALL BE SHUTDOWN. REFER TO SHUTDOWN MODE.

2 IF A CONTROLLING SENSOR IS DETERMINED TO HAVE FAILED THAT WOULD DAMAGE THE EQUIPMENT OR CAUSE INAPPROPRIATE CONDITIONS IN THE SPACE, THE UNIT SHALL BE SHUT DOWN. REFER TO SHUTDOWN MODE.

SHUTDOWN MODE CONTROL

1 UPON A SHUTDOWN COMMAND FROM THE DDC SYSTEM OR A SAFETY CONTROL DEVICE COMMAND, THE UNIT SHALL COMMENCE A SHUT DOWN MODE.

2 THE SUPPLY AND EXHAUST FANS ARE COMMANDED OFF UNLESS IN A FIRE EVENT ASSOCIATED WITH THE HOOD.

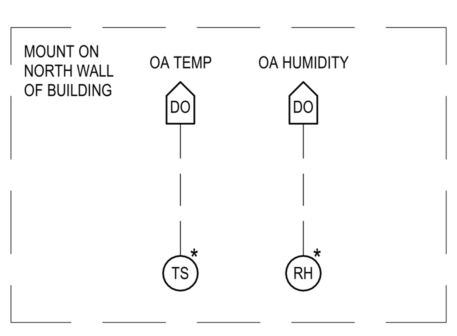
3 DAMPERS ASSOCIATED WITH FANS COMMANDED OFF CLOSE AFTER A 5 MINUTE DELAY (ADJ)

SET POINTS

1 HEATING SPACE TEMPERATURE SET POINT 70°F

5 M-701 OVEN HOOD CONTROL SYSTEM DIAGRAM

12" = 1'-0"



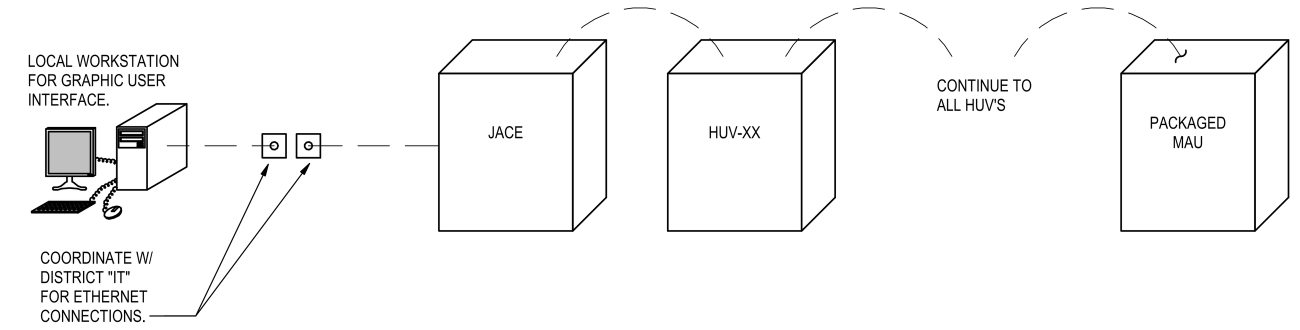
SEQUENCE OF OPERATION

GENERAL

1. THE DDC MONITORS OUTSIDE AIR TEMPERATURE AND HUMIDITY AND MAKES THESE VALUES AVAILABLE TO ALL CONTROLLERS WHICH REQUIRE THEM.
2. OUTSIDE AIR CONDITIONS ARE AVAILABLE ON THE GRAPHIC USER INTERFACE.
3. OUTSIDE AIR CONDITIONS ARE TRENDED FOR DIAGNOSTIC PURPOSES AND FOR COMPARATIVE ENERGY USAGE.

4 M-701 OUTSIDE AIR TEMPERATURE AND HUMIDITY MONITORING

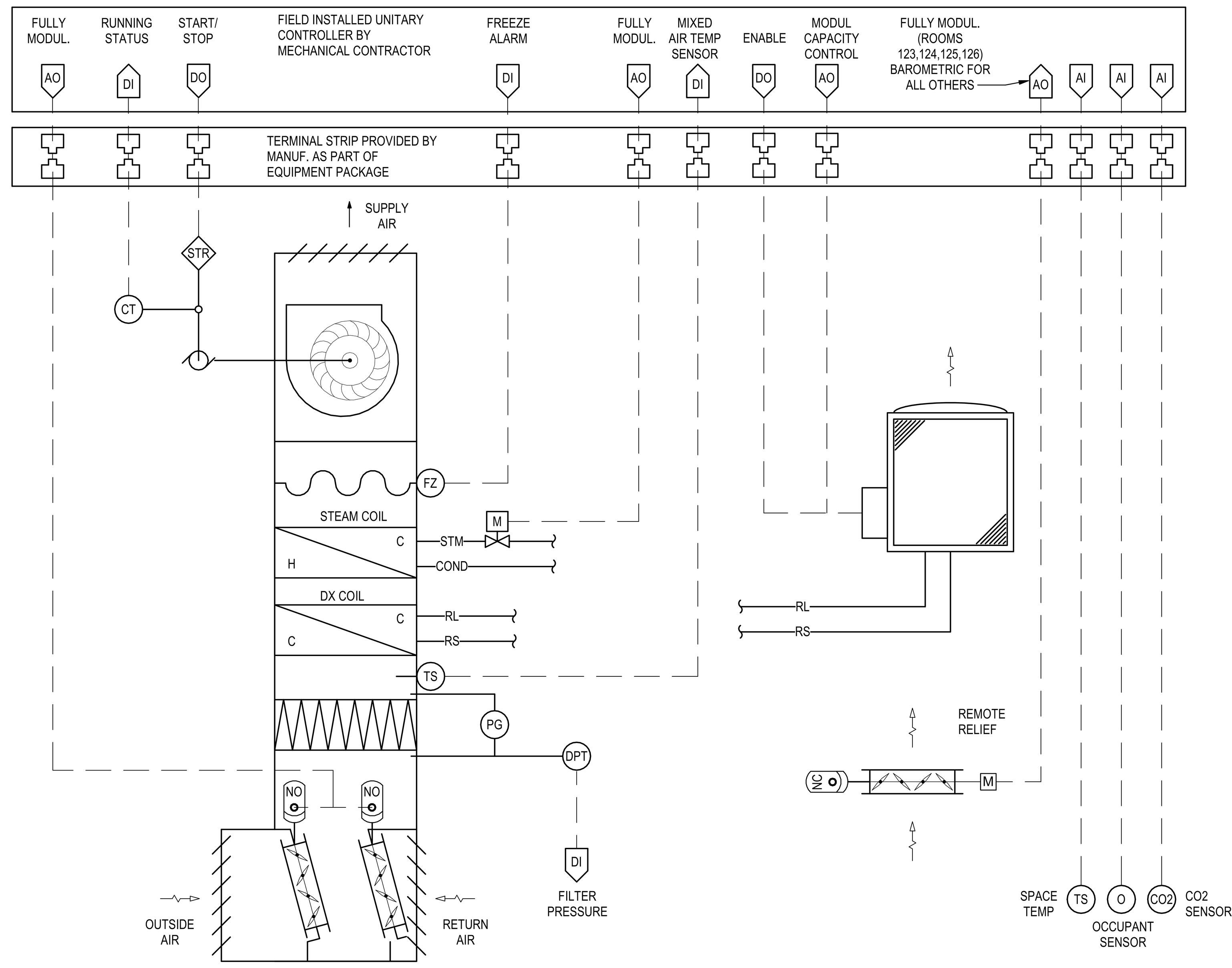
NOT TO SCALE



DDC SYSTEM ARCHITECTURE

NOTES

1. REFER TO GENERAL TEMPERATURE CONTROL REQUIREMENTS NOTES.
2. PROVIDE AUXILIARY PANELS AND ALL NECESSARY COMPONENTS FOR A COMPLETE AND OPERATIONAL SYSTEM.
3. COORDINATE EXACT LOCATIONS OF PANELS AND DEVICES IN FIELD.
4. THE ARCHITECTURE IS DIAGRAMMATIC IN NATURE AND REPRESENTS THE MINIMUM NUMBER OF CONTROL PANELS FOR THE SYSTEM.
5. PROVIDE SURPLUS I/O MODULES NOT LESS THAN 10% OF TOTAL PANEL POPULATION FOR ADDITIONAL POINTS.



SEE SCHEDULES FOR QUANTITIES AND PLANS FOR LOCATIONS

SEQUENCE OF OPERATION

GENERAL

1. PROVIDE WITH DDC CONTROLS PROGRAMMED TO THE SEQUENCE OF OPERATION DESCRIBED WITHIN THE CONTRACT DOCUMENTS. PROVIDE DDC CONTROLLER AND INSTALL ALL NECESSARY COMPONENTS AND ACCESSORIES FOR A COMPLETE AND OPERATIONAL SYSTEM INCLUDING, BUT NOT LIMITED TO SENSORS, RELAYS, GATEWAYS, COMMUNICATION WIRING AND CONDUIT, AND ALL NECESSARY ELECTRICAL DEVICES, WIRING, AND CONDUIT.
2. PROGRAM ALL POINTS IDENTIFIED IN THE CONTRACT DOCUMENTS TO BE VISIBLE ON THE USER'S GRAPHIC INTERFACE. ALARMS AND OTHER SYSTEM NOTIFICATIONS ARE REPORTED TO SYSTEM USERS.
3. ALL HAND-OFF-AUTO (HOA) SWITCHES NORMALLY REMAIN IN THE "AUTO" POSITION AND THE "HAND" AND "OFF" POSITIONS ARE USED FOR MAINTENANCE SITUATIONS. ALL SET POINTS, DEAD BANDS, AND TIME DELAY INTERVALS DESCRIBED IN SEQUENCE ARE ADJUSTABLE BY SYSTEM OPERATORS. SPECIFIC POINTS IDENTIFIED WITH (ADJ) ARE TO BE ADJUSTABLE THROUGH THE USER INTERFACE. APPROPRIATE DEAD BANDS AND TIME DELAYS ARE TO BE PROVIDED TO PREVENT SIMULTANEOUS HEATING-COOLING OPERATION, OR SHORT CYCLING SITUATIONS. ALL DEAD BANDS AND TIME DELAYS MAY BE ADJUSTED WITHOUT HAVING TO CHANGE LINES OF CODE.

SCHEDULING

1 PROVIDE TIME OF DAY SCHEDULING FUNCTIONALITY THROUGH THE CONTROL SYSTEM. DURING OCCUPIED MODES, THE UNIT RUNS CONTINUOUSLY UNLESS SHUT DOWN FOR MAINTENANCE OR A SAFTEY TRIP.

2. OCCUPIED AND UNOCCUPIED SCHEDULES ARE TO BE VERIFIED DURING SYSTEM COMMISSIONING OR OWNER TRAINING. CONTRACTOR TO SET UP SCHEDULES WITH OWNER'S PERSONNEL.

CONTROL MODES

1. THE UNIT VENTILATOR OPERATES IN THE FOLLOWING MODES:
   A. OCCUPIED MODE
   B. UNOCCUPIED MODE
2. REFER TO EACH CONTROL SECTION FOR REQUIREMENTS.

SUPPLY FAN CONTROL

1 UPON A CALL TO START, THE CONTROL SYSTEM ENERGIZES THE FAN'S MOTOR STARTER.

2 FOR EC MOTORS, THE CONTROL SYSTEM SHALL MODULATE THE SIGNAL TO THE FAN SPEED ASSOCIATED WITH THE CURRENT MODE OF OPERATION.

3 DURING THE OCCUPIED MODE, THE SUPPLY FAN RUNS CONTINUOUSLY.

4 DURING THE UNOCCUPIED MODE, THE SUPPLY FAN RUNS UPON A CALL FOR HEATING OR COOLING.

VENTILATION CONTROL

1. DURING THE OCCUPIED AND STANDBY MODES, THE CONTROL SYSTEM MODULATES THE RETURN, OUTSIDE AIR, AND REMOTE RELIEF AIR DAMPERS TO THE SET POINTS DETERMINED IN SYSTEM BALANCING.
2. DURING THE UNOCCUPIED MODE, THE OUTSIDE AIR, AND REMOTE RELIEF DAMPERS REMAIN CLOSED AND THE RETURN AIR DAMPER REMAINS OPEN.

VENTILATION RESET CONTROL

1. THE SYSTEM SHALL HAVE VENTILATION RESET CAPABILITY.
2. THE OUTSIDE AIRFLOW SET POINT MAY BE RESET BETWEEN THE SCHEDULED DESIGN OUTSIDE AIRFLOW RATE AND THE SCHEDULED MINIMUM OUTSIDE AIR RATE.
3. THE CONTROL SYSTEM MONITORS THE SPACE CO2 LEVEL.
4. THE CONTROL SYSTEM RESETS OUTSIDE AIRFLOW FROM DESIGN OUTSIDE AIRFLOW TO MINIMUM OUTSIDE AIR TO MAINTAIN A CO2 SET POINT OF 1000 PPM (ADJ)
5. DURING ECONOMIZER, THE OUTSIDE AIRFLOW RATE SHALL BE ALLOWED TO RISE ABOVE THE DESIGN OUTSIDE AIRFLOW RATE TO THE MAXIMUM UNIT SUPPLY AIRFLOW RATE.

SEQUENCE OF OPERATION (CONTINUED)

HEATING MODE CONTROL

1 THE CONTROL SYSTEM MODULATES THE HEATING CONTROL VALVE TO MAINTAIN THE SPACE TEMPERATURE SET POINT.

COOLING MODE CONTROL

1 THE CONTROL SYSTEM ENABLES THE REFRIGERATION SYSTEM TO MAINTAIN THE SPACE TEMPERATURE SET POINT.

FILTER MONITORING

1 DDC MONITORS AND DISPLAYS THE AIR FILTER PRESSURE DROPS AND ISSUE A DIRTY FILTER ALARM WHEN THE DIFFERENTIAL PRESSURE REACHES 90% (ADJ) OF THE SCHEDULED VALUE.

ECONOMIZER COOLING MODE CONTROL

1 WHENEVER OUTSIDE ENTHALPY IS LESS THAN RETURN ENTHALPY, THE CONTROL SYSTEM UTILIZES OUTSIDE AIR AS THE FIRST STAGE OF COOLING.

2 THE CONTROL SYSTEM MODULATES THE RETURN, OUTSIDE AIR, AND REMOTE RELIEF AIR DAMPERS PROPORTIONALLY AS DETERMINED IN SYSTEM BALANCING.

SAFETY CONTROL

1 THE CONTROL SYSTEM MONITORS FAN STATUS. UPON A FAILURE, AN ALARM IS ISSUED.

SHUT DOWN MODE

1 UPON A SHUTDOWN COMMAND FROM THE CONTROL SYSTEM OR A SAFETY CONTROL DEVICE COMMAND, THE UNIT SHALL COMMENCE A SHUT DOWN MODE.

2 THE SUPPLY FAN IS DE-ENERGIZED.

3 THE OUTSIDE AIR DAMPER CLOSES AND THE RETURN DAMPER OPENS

4 THE COOLING SYSTEM CYCLES OFF.

5 THE HEATING VALVE MODULATES OPEN TO MAINTAIN A PLENUM TEMPERATURE OF 75°F (ADJ).

SET POINTS

1	OCCUPIED HEATING SET POINT	70°F (ADJ)
2	OCCUPIED COOLING SET POINT	75°F (ADJ)
3	UNOCCUPIED HEATING SET POINT	62°F (ADJ)
4	UNCOCUPIED COOLING SET POINT	80°F (ADJ)

TREND DATA

1 PROVIDE TRENDING FUNCTIONS FOR ALL CONTROL AND MONITORING POINTS.

2 SET UP SPECIFIC TRENDS AS DEFINED BY USER DURING SYSTEM TRAINING. TRENDS ARE TO BE MAINTAINED FOR ONE MONTH INTERVALS AND ARE THEN ARCHIVED FOR USE FOR SYSTEM DIAGNOSTICS AND MEASUREMENT AND VERIFICATION OF SYSTEMS.

3 PROVIDE TRENDS TO SUPPORT COMMISSIONING ACTIVITIES AS DEFINED BY COMMISSIONING PLAN. REFER TO COMMISSIONING SPECIFICATIONS AND COMMISSIONING PLAN FOR REQUIREMENTS.

NOTE

MOTORIZED REMOTE RELIEF DAMPERS ARE PROVIDED FOR HUV-123,124,125 AND 126 ONLY. ALL OTHER HUV SYSTEMS UTILIZE BAROMETRIC DAMPERS.

3 M-701 TYPICAL HORIZONTAL UNIT VENTILATOR CONTROL DIAGRAM

NOT TO SCALE

CONTROLS

SYMBOL	DESCRIPTION
PG	AIR PRESSURE GAGE
CO2	CARBON DIOXIDE SENSOR
CT	CURRENT TRANSMITTER
CT	CURRENT TRANSMITTER WITH LEAD
DPS	DIFFERENTIAL PRESSURE SENSOR
DPT	DIFFERENTIAL PRESSURE TRANSMITTER
FM	FLOW METER
FS	FLOW SWITCH
FT	FLOW TRANSMITTER
FZ	FREEZE STAT
HOA	HAND SWITCH
H	HUMIDITY SENSOR
LC	LEVEL CONTROL
LS	LIMIT SWITCH
LPI	LOOP POWERED INDICATOR
O	OCCUPANCY SENSOR
PI	POSITION INDICATOR
PS	PRESSURE SENSOR
R	REFRIGERANT SENSOR
RH	RELATIVE HUMIDITY SENSOR
R	RELAY
SP	STATIC PRESSURE SENSOR
T	THERMOSTAT
AFS	AIR FLOW SWITCH
I / P	CURRENT TO PRESSURE
E / P	ELECTRIC TO PNEUMATIC
SCR	SILICON CONTROLLED RECITIFIER
TCP	TEMPERATURE CONTROL PANEL
TEC	TERMINAL EQUIPMENT CONTROLLER
	SENSOR WELL
	ALARM HORN
	ALARM BEACON
AI	ANALOG INPUT
AO	ANALOG OUTPUT
DI	DIGITAL INPUT
DO	DIGITAL OUTPUT
EC	ELECTRICALLY COMMUTED MOTOR
STR	STARTER
HOA	HAND OFF AUTO
VFD	VARIABLE FREQUENCY DRIVE
	NON MOTORIZED VALVE
M	TWO WAY MOTORIZED VALVE
M	THREE WAY MOTORIZED VALVE

CONTROLS

SYMBOL	DESCRIPTION
S	TWO WAY SOLENOID VALVE
NC O NO	THREE WAY SOLENOID VALVE
	PUMP
	MOTOR
S	DUCT SMOKE DETECTOR
H	HEAT DETECTOR
H C	UNITARY HEATING COIL
C C	UNITARY COOLING COIL
	FILTER
	AIR BLENDER
	ENERGY WHEEL
	PLATE ENERGY RECOVERY COIL
	AIR FLOW MEASURING STATION
	BACKDRAFT DAMPER
	MOTORIZED DAMPER - PARALLEL BLADE
	MOTORIZED DAMPER - OPPOSED BLADE
NC	DAMPER ACTUATOR - ELECTRIC
NC	DAMPER ACTUATOR - PNEUMATIC
	CENTRIFUGAL FAN
	PROP FAN
	PLENUM FAN
	HUMIDIFIER
	ETHERNET CONNECTION
	PILOT LIGHT
	ELECTRICAL CONNECTION
©	CONTACTOR
	CONTACT
DDC_XXX	DDC PANEL
	COMPUTER

GENERAL TEMPERATURE CONTROL REQUIREMENTS

1 PROVIDE ALL POWER, INTERCONNECTING WIRING, TRANSFORMERS, AUTOMATIC VOLTAGE REGULATION, UNINTERUPTABLE POWER SYSTEMS, ENCLOSURES, RACEWAYS, CONDUITS, HANGERS, AND SUPPORTS FOR A COMPLETE AND OPERATIONAL SYSTEM. ROUTE POWER FROM NEW OR EXISTING ELECTRICAL PANELS. COORDINATE WITH ELECTRICAL CONTRACTOR FOR ALLOWABLE PANEL LOADING REQUIREMENTS AND CIRCUIT NUMBERS. IN EXISTINIG OR NEW PANEL BOARDS, SPARE CIRCUITS MAY BE USED WHEN AVAILABLE. IN PANELBOARDS THAT DO NOT HAVE SPARE CIRCUIT BREAKER, PROVIDE NEW BREAKERS TO MATCH EXISTING BREAKERS IN OPEN SPACES. LOW VOLTAGE WIRING WILL BE ROUTED SEPARATELY THAN 120 V WIRING.

2 ALL WIRING SHALL BE IN COMPLIANCE WITH THE NATIONAL ELECTRICAL CODE AND PROJECT SPECIFICATION REQUIREMENTS.

3 PROVIDE INDIVIDUAL GRAPHICS FOR EACH DEVICE IDENTIFIED IN THE CONTRACT DOCUMENTS. REFER TO ALL DRAWINGS.

4 ALL SET POINTS AND DEAD BANDS TO BE ADJUSTABLE THROUGH A GRAPHICAL USER INTERFACE.

5 PROVIDE ALL NECESSARY VIRTUAL POINTS, CONTROLLERS, RELAYS, CONTACTORS, INTERFACE MODULES, COMMUNICATION CARDS, AND OTHER DEVICES TO MEET THE SPECIFIED SEQUENCE OF OPERATION FOR EACH DEVICE.

6 COORDINATE EXACT LOCATIONS OF ALL FIELD MOUNTED COMPONENTS.

7 ALL RELAYS, TRANSFORMERS, TRANSDUCERS, AND OTHER DEVICES ASSOCIATED WITH THE CONTROL SYSTEM SHALL BE MOUNTED WITHIN STANDARD ENCLOSURES OR AUXILARY PANELS.

8 COORDINATE DAMPER, VALVE, AND CONTROL DEVICE LOCATIONS AND SIZES WITH MECHANICAL TRADES.

9 CONTROL SYSTEM TO INCLUDE ALL COMPONENTS INCLUDED IN CONTRACT DOCUMENTS. PROVIDE ALL NECESSARY INTEGRATION AND LICENSING TO VIEW NEW COMPONENTS FROM THE EXISTING CAMPUS GRAPHIC USER INTERFACE. COORDINATE ACCESS TO BUILDING NETWORK WITH IT PERSONEL.

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TEMPERATURE CONTROLS LEGEND AND DIAGRAMS
REVISIONS
REV | DESCRIPTION | DATE
PROJ. #: 214100605
DATE: 11-NOV-2022
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M-701
CONSTRUCTION DOCUMENTS

WE RECYCLE
THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID
BLACK
WHITE
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DESIGNED BY: Designer
CHECKED BY: Checker APPROVED BY: Approver

WE RECYCLE

THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK

BLACK
WHITE

ABBREVIATIONS

1/C	SINGLE CONDUCTOR
Φ	PHASE
A	AMPS
A/C	AIR CONDITIONING UNIT
AC	ALTERNATING CURRENT
ACH	ABOVE COUNTER HEIGHT
ACT	ABOVE CEILING TILE
ADA	AMERICANS WITH DISABILITIES ACT
ADJ	ADJUSTABLE
AF	AMP FRAME
AFC	ABOVE FINISHED CEILING
AFCI	ARC FAULT CIRCUIT INTERRUPTER
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
AHJ	AUTHORITY HAVING JURISDICTION
AHU	AIR HANDLING UNIT
AIC	AMPS INTERRUPTING CAPACITY
AL	ALUMINUM
ALD	ASSISTED LISTENING DEVICE
ALT	ALTERNATE
ARCH	ARCHITECTURAL
AS	AMP SWITCH
AT	AMP TRIP
ATS	AUTOMATIC TRANSFER SWITCH
AUTO	AUTOMATIC
AV	AUDIO VISUAL
AVG	AVERAGE
AWG	AMERICAN WIRE GAUGE
BC	BONDING CONDUCTOR
BCU	BARE COPPER
BFC	BELOW FINISHED CEILING
BFG	BELOW FINISHED GRADE
BKR	BREAKER
BLDG	BUILDING
BOF	BOTTOM OF FIXTURE
BTM	BOTTOM
C	CONDUIT
C/W	COMPLETE WITH
CAP	CAPACITY
CATV	CABLE ANTENNA TELEVISION
CB	CIRCUIT BREAKER
CCTV	CLOSED CIRCUIT TELEVISION
CEC	CANADIAN ELECTRIC CODE
CFOI	CONTRACTOR FURNISHED, OWNER INSTALLED
CIRC	CIRCULATING
CKT	CIRCUIT
CL	CENTERLINE
CLG	CEILING
CM	CEILING MOUNTED
CMU	CONCRETE MASONRY UNIT
CO	CONDUIT ONLY
COMM	COMMUNICATIONS
CONC	CONCRETE
CONN	CONNECTION
CONST	CONSTRUCTION
CONT	CONTINUOUS
CONTR	CONTRACTOR
CPT	CONTROL POWER TRANSFORMER
CPU	CENTRAL PROCESSING UNIT
CR	CRITICAL BRANCH
CT	CURRENT TRANSFORMERS
CTR	CENTER
CU	COPPER
CUH	CABINET UNIT HEATER
D	DEDICATED
DC	DIRECT CURRENT
DET	DETAIL
DIAM	DIAMETER
DIM	DIMENSION
DISC	DISCONNECT
DIV	DIVISION
DL	DAMP LOCATION
DN	DOWN
DP	DISTRIBUTION PANEL
DPDT	DOUBLE POLE, DOUBLE THROW
DPR	DAMPER
DPST	DOUBLE POLE, SINGLE THROW
DWG	DRAWING
DWH	DOMESTIC WATER HEATER

ABBREVIATIONS

EA	EACH
EC	ELECTRICAL CONTRACTOR
EF	EXHAUST FAN
ELEC	ELECTRICAL
ELEV	ELEVATOR
EM	EMERGENCY
EM GEN	EMERGENCY GENERATOR
EMT	ELECTRICAL METALLIC TUBING
ENCL	ENCLOSURE
EP	ELECTRIC-PNEUMATIC
EPO	EMERGENCY POWER OFF
EQ	EQUIPMENT BRANCH
EQUIP	EQUIPMENT
ERL	EXISTING TO BE RELOCATED
ETD	EMERGENCY TRANSFER DEVICE
EWC	ELECTRIC WATER COOLER
EXH	EXHAUST
EXIST, E, EX	EXISTING
EXP	EXPLOSION PROOF
EXTER	EXTERIOR
F&I	FURNISHED AND INSTALLED
FA	FIRE ALARM
FAA	FIRE ALARM ANNUNCIATOR
FACP	FIRE ALARM CONTROL PANEL
FB	FLOOR BOX
FCU	FAN COIL UNIT
FLR	FLOOR
FLUOR	FLUORESCENT
FO	FIBER (FIBRE) OPTIC
FP	FIRE PROTECTION
FS	FUSIBLE SWITCH
FSCS	FIRE FIGHTER SMOKE CONTROL STATION
FU	FUSE
FVNR	FULL VOLTAGE NON REVERSING
FVR	FULL VOLTAGE REVERSING
G, GND	GROUND
G/Y	GREEN YELLOW
GA	GAUGE
GAL	GALLONS
GC	GENERAL CONTRACTOR
GEN	GENERATOR
GFI, GFCI	GROUND FAULT (CIRCUIT) INTERRUPTER
H	HOT CONDUCTOR
HC	HORIZONTAL CROSS CONNECT
HD	HAND DRYER
HFF	HAND FREE FIXTURE
HGT	HEIGHT
HH	HANDHOLE
HID	HIGH INTENSITY DISCHARGE
HK	HOUSE KEEPING PAD
HM	HORIZONTALLY MOUNTED
HOA	HAND-OFF-AUTO
HOR	HORIZONTAL
HP	HORSEPOWER
HTG	HEATING
HV	HIGH VOLTAGE
HVCB	HIGH VOLTAGE CIRCUIT BREAKER
HW	HOT WATER
HZ	HERTZ
IC	INTERMEDIATE CROSS CONNECT
ID	INSIDE DIAMETER
IDF	INTERMEDIATE DISTRIBUTION FRAME
IG	ISOLATED GROUND
IMC	INTERMEDIATE METAL CONDUIT
INST	INSTANTANEOUS
IP	INTERNET PROTOCOL
JB	JUNCTION BOX
K	KIRK KEY INTERLOCK
KAIC	KILO-AMPS INTERRUPTING CAPACITY
KV	KILOVOLT
KVA	KILOVOLT-AMPERES
KW	KILOWATT
LED	LIGHT EMITTING DIODE
LR	LEGALLY REQUIRED
LS	LIFE SAFETY BRANCH
LSIG	LONG TIME, SHORT TIME, INSTANTANEOUS, GROUND FAULT
LTG	LIGHTING
LV	LOW VOLTAGE

ABBREVIATIONS

MAU	MAKE UP AIR UNIT
MAX	MAXIMUM
MC	METAL CLAD CABLE
MCA	MINIMUM CIRCUIT AMPS
MCB	MAIN CIRCUIT BREAKER
MCC	MOTOR CONTROL CENTER
MCCB	MOLDED CASE CIRCUIT BREAKER
MCP	MOTOR CIRCUIT PROTECTOR
MCT	MAIN CROSS CONNECT
MDF	MAIN DISTRIBUTION FRAME
MDP	MAIN DISTRIBUTION PANEL
MECH	MECHANICAL
MET	MAIN EARTHING TERMINAL
MFR	MANUFACTURER
MH	MANHOLE
MIN	MINIMUM
MISC	MISCELLANEOUS
MLO	MAIN LUG ONLY
MM	MULTIMODE FIBER (FIBRE) OPTIC STRAND
MSB	MAIN SWITCHBOARD
MTD	MOUNTED
MTG	MOUNTING
MTS	MAIN TERMINAL SPACE
MV	MEDIUM VOLTAGE
MVCB	MEDIUM VOLTAGE CIRCUIT BREAKER
MW	MICROWAVE OVEN
N	NEUTRAL
NAC	NOTIFICATION APPLIANCE CIRCUIT
NC	NORMALLY CLOSED
NEC	NATIONAL ELECTRIC CODE
NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
NIC	NOT IN CONTRACT
NL	NIGHT LIGHT
NO	NORMALLY OPEN
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
OFCI	OWNER FURNISHED, CONTRACTOR INSTALLED
OFE	OWNER FURNISHED EQUIPMENT
OH	OVERHEAD
OL	OVERLOAD
OS	OCCUPANCY SENSOR, OPTIONAL STANDBY
OSP	OUTSIDE PLANT
P	POLE
PA	PUBLIC ADDRESS
PB	PULL BOX
PD	PUNCHDOWN
PF	POWER FACTOR
PH	PHASE
PNL	PANEL
POE	POINT OF ENTRANCE
POS	POINT OF SERVICE
PR	PAIR
PT	POTENTIAL TRANSFORMERS
PTS	PNEUMATIC TUBE STATION
PTZ	PAN/TILT/ZOOM
PV	PHOTOVOLTAIC
PVC	POLYVINYL CHLORIDE CONDUIT
PWR	POWER
R	RELOCATED
RA	RETURN AIR
REC	RECESSED
RECP	RECEPTACLE
REQD	REQUIRED
REX	REQUEST TO EXIT
RM	ROOM
RNC	RIGID NON-METALLIC CONDUIT
RO	RACEWAY ONLY
RSC, RGS	RIGID STEEL CONDUIT
SCCR	SHORT CIRCUIT CURRENT RATING
SEC	SECURITY
SECT	SECTION
SIM	SIMILAR
SM	SINGLE MODE FIBER OPTIC STRAND
SMR	SURFACE MOUNTED RACEWAY
SPD	SURGE PROTECTED DEVICE
SPDT	SINGLE POLE DOUBLE THROW
SPECS	SPECIFICATIONS
SPST	SINGLE POLE SINGLE THROW
SS	STAINLESS STEEL
ST	SHUNT TRIP
STD	STANDARD
SW	SWITCH
SWBD	SWITCHBOARD
SWGR	SWITCHGEAR
SYS	SYSTEM

ABBREVIATIONS

TBB	TELECOMMUNICATIONS BACKBONE
TC	TEMPERATURE CONTROL OR TERMINAL CABINET
TE	TELECOMMUNICATIONS ENCLOSURE
TELE	TELEPHONE
TELECOM	TELECOMMUNICATIONS
TEMP	TEMPERATURE
TERM	TERMINAL
TGB	TELECOMMUNICATIONS GROUND BAR
TMGB	TELECOMMUNICATIONS MAIN GROUND BAR
TOF	TOP OF FIXTURE
TP	TAMPER RESISTANT
TR	TELECOMMUNICATIONS ROOM
TSP	TWISTED SHIELDED PAIR
TSTAT	THERMOSTAT
TTB	TELECOM TERMINAL BOARD
TV	TELEVISION
TYP	TYPICAL
UG	UNDERGROUND
UH	UNIT HEATER
UNO	UNLESS NOTED OTHERWISE
UPS	UNINTERRUPTIBLE POWER SUPPLY
USB	UNIVERSAL SERIAL BUS
UTP	UNSHIELDED TWISTED PAIR
UV	UNIT VENTILATOR
V	VOLTS
VA	VOLT-AMPS
VAV	VARIABLE AIR VOLUME
VC	VOLUME CONTROL
VDT	VISUAL DISPLAY TERMINAL
VERT	VERTICAL
VFD	VARIABLE FREQUENCY DRIVE
VIF	VERIFY IN FIELD
VOL	VOLUME
VT	VAPOR TIGHT
W	WIRE, WATT
WAP	WIRELESS ACCESS POINT
WG	WIREGUARD
WL	WET LOCATION
WP	WEATHERPROOF
WT	WATERTIGHT
XFMR	TRANSFORMER

WORK DEFINITION

	NEW WORK
	EXISTING
	REMOVE EXISTING
×××	REMOVE EXISTING ELECTRICAL EQUIPMENT
	FUTURE
	TEMPORARY, AS NOTED
?##	KEY NOTE
???	EQUIPMENT IDENTIFICATION

TELECOM OUTLETS

	OUTLET
	OUTLET, CEILING MOUNTED
	OUTLET, MOUNTED IN FLOOR BOX
	OUTLET, MOUNTED IN POKE THRU
	OUTLET, MOUNTED IN POWER POLE

TELECOM OUTLET TYPES

#	# INDICATES QUANTITY OF DATA JACKS, PULLSTRING ALWAYS PROVIDED. WHERE NO QUANTITY IS NOTED, 2 DATA JACKS AND PULLSTRING.
AC	MOUNTED 3" ABOVE COUNTER BACKSPLASH
B	BLANK FACEPLATE, ROUGH-IN ONLY
D	DIRECT CONNECTION TO PANEL
M	PATIENT MONITORING
P	PAY TELEPHONE
R	RACEWAY MOUNTED
W	WALL MOUNTED TELEPHONE HANDSET OUTLET
WAP	WIRELESS ACCESS POINT CONNECTION

TELECOM MISCELLANEOUS

	CABLE TRAY WITH FLANGE SIDE RAILS AND LADDER RUNGS
	CABLE TRAY
	BUNDLED CABLE SUPPORT, J-HOOK SYSTEM
	BUNDLED CABLE SUPPORT, J-HOOK SYSTEM, CEILING MOUNTED
	BUNDLED CABLE SUPPORT, J-HOOK SYSTEM, PENDANT MOUNTED
	GROUND BAR, LENGTH TO SCALE
	RAISED FLOOR GROMMET
WAP	WIRELESS ACCESS POINT
WAP	WIRELESS ACCESS POINT, CEILING MOUNTED

AUDIO VISUAL

	CONTROL PANEL
$LV	LOW VOLTAGE SWITCH
	MICROPHONE, CEILING MOUNTED
	MICROPHONE, WALL MOUNTED
	SYSTEMS TERMINAL CABINET, DRAWN TO SCALE
	TV CONTROL
AL	ASSISTIVE LISTENING, CEILING MOUNTED
AL	ASSISTIVE LISTENING, WALL MOUNTED
AV	AUDIO VISUAL PANEL
C	VIDEO CAMERA, CEILING MOUNTED
C	VIDEO CAMERA, WALL MOUNTED
IR	INFRARED RECEIVER, CEILING MOUNTED
IR	INFRARED RECEIVER, WALL MOUNTED
RF	RADIO FREQUENCY RECEIVER, CEILING MOUNTED
RF	RADIO FREQUENCY RECEIVER, WALL MOUNTED
S	SPEAKER, RECESSED AND CEILING MOUNTED
S	SPEAKER, SURFACE AND CEILING MOUNTED
S	SPEAKER, PENDANT MOUNTED
S	SPEAKER, RECESSED AND WALL MOUNTED
S	SPEAKER, SURFACE AND WALL MOUNTED
S	SPEAKER/MICROPHONE, RECESSED AND CEILING MOUNTED
S	SPEAKER/MICROPHONE, RECESSED AND WALL MOUNTED
TV	CATV OUTLET, CEILING MOUNTED
TV	CATV OUTLET, WALL MOUNTED
VC	VOLUME CONTROLLER
VD	VIDEO DISPLAY, CEILING MOUNTED
VD	VIDEO DISPLAY, RECESSED AND WALL MOUNTED
VD	VIDEO DISPLAY, SURFACE AND WALL MOUNTED
VP	VIDEO PROJECTOR, CEILING MOUNTED
VP	VIDEO PROJECTOR, RECESSED AND WALL MOUNTED
VP	VIDEO PROJECTOR, SURFACE AND WALL MOUNTED

FIRE ALARM

	FIRE SERVICE PHONE STATION OUTLET
	FLAME DETECTOR
CO	GAS DETECTOR, CARBON MONOXIDE
	HORN AND STROBE LIGHT, CEILING MOUNTED
	HORN AND STROBE LIGHT, WALL MOUNTED
	REMOTE INDICATOR, CEILING MOUNTED
	REMOTE INDICATOR, WALL MOUNTED
	SPEAKER AND STROBE LIGHT, CEILING MOUNTED
	SPEAKER AND STROBE LIGHT, WALL MOUNTED
	STROBE LIGHT, CEILING MOUNTED
	STROBE LIGHT, WALL MOUNTED
AIM	ADDRESSABLE INPUT MODULE
ARCM	AREA OF REFUGE COMMUNICATION MASTER UNIT
ARCR	AREA OF REFUGE COMMUNICATION REMOTE UNIT
AOM	ADDRESSABLE OUTPUT MODULE
D	ELECTRICALLY OPERATED SMOKE OR FIRE/SMOKE DAMPER CONNECTION
DCL	DOOR CLOSER
DH	DOOR HOLDER
F	CHIME, WALL MOUNTED
F	HORN, CEILING MOUNTED
F	HORN, WALL MOUNTED
F	PULL STATION
FAA	FIRE ALARM ANNUNCIATOR
FACP	FIRE ALARM CONTROL PANEL
FAT	FIRE ALARM TRANSMITTER
FATC	FIRE ALARM TERMINAL CABINET
GAP	GRAPHIC ANNUNCIATOR PANEL
H F#	HEAT DETECTOR, FIXED TEMPERATURE, # INDICATES °F OR °C
H RF	HEAT DETECTOR, COMBINED RATE OF RISE/FIXED TEMPERATURE
H R	HEAT DETECTOR, RATE OF RISE
NAC	FIRE ALARM NOTIFICATION APPLIANCE CIRCUIT PANEL
PS	PRESSURE DETECTOR/SWITCH
S AS	SMOKE DETECTOR, AIR SAMPLING
S BR	SMOKE DETECTOR, BEAM DETECTOR RECEIVER
S BT	SMOKE DETECTOR, BEAM DETECTOR TRANSMITTER
S E	SMOKE DETECTOR, ELEVATOR RECALL
S I	SMOKE DETECTOR, IONIZATION
S ID	SMOKE DETECTOR, IN DUCT
S P	SMOKE DETECTOR, PHOTOELECTRIC
SS	SMOKE DETECTOR, SINGLE STATION
S H	SMOKE/HEAT DETECTOR
S H CO	SMOKE/HEAT/CARBON MONOXIDE DETECTOR
S	SPEAKER, CEILING MOUNTED
S	SPEAKER, WALL MOUNTED
VS	VALVE SUPERVISORY TAMPER SWITCH
WF	FLOW DETECTOR/SWITCH
	FIRE/SMOKE DAMPER

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ELECTRICAL SYMBOLS AND ABBREVIATIONS

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0179
DATE: 11-NOV-2022
SHEET
E-001

CONSTRUCTION DOCUMENTS

ELECTRICAL SCHEMATICS

Symbol	Description
C# / 3 1 G	CABLE IDENTIFICATION, TABLE CIRCUIT RATING, SEE FEEDER TABLE A = ALUMINUM C = COPPER M = METAL CLAD GROUND REQUIRED, SIZE PER FEEDER TABLE G = YES - = NO NEUTRAL CONDUCTOR REQUIREMENT, SIZE PER FEEDER TABLE - = NOT REQUIRED 1 = 1 NEUTRAL CONDUCTOR 2 = 200% NEUTRAL (2 NEUTRAL CONDUCTORS) QUANTITY OF PHASE CONDUCTORS, SIZE PER FEEDER TABLE
4 #12+ #12G, [SIZE]C	CABLE IDENTIFICATION, LEADER CONDUIT SIZE GROUND SIZE, IF BLANK NO GROUND REQUIRED QUANTITY AND SIZE OF CONDUCTORS
4 SETS (3x1/C 600 kcmil, Cu, TR-XLPE, 15kV, 133%+#3/0G, [SIZE]C)	CABLE IDENTIFICATION, LEADER CONDUIT SIZE GROUND SIZE, IF BLANK NO GROUND REQUIRED CONDUCTOR FEATURES QUANTITY AND SIZE OF CONDUCTORS QUANTITY OF SETS
0	SHORT CIRCUIT CURRENT RATING
	BUS DUCT
	BUS
	FEEDER
NAME . 225 A 480 V 3 Ø, 4 W 42 CCT	PANEL, SINGLE TUB
NAME LOCATION	PANEL, DOUBLE TUB, MAIN LUGS
NAME LOCATION / NAME .	PANEL, DOUBLE TUB, FEED THRU LUGS
	AC/DC INVERTER
	AUTOTRANSFORMER
	AUTOMATIC TRANSFER SWITCH, DUAL BYPASS
	AUTOMATIC TRANSFER SWITCH, SINGLE BYPASS
	BATTERY
	BIMETALLIC THERMAL OVERLOAD
	CAPACITOR

ELECTRICAL SCHEMATICS

- CIRCUIT BREAKER, LOW VOLTAGE, DRAW OUT
- CIRCUIT BREAKER, LOW VOLTAGE, FIXED
- CIRCUIT BREAKER, LOW VOLTAGE, WITH LIMITER
- CIRCUIT BREAKER, MEDIUM VOLTAGE, DRAW OUT
- CIRCUIT BREAKER, MEDIUM VOLTAGE, FIXED
- CIRCUIT BREAKER, MEDIUM VOLTAGE, VACUUM INTERRUPTER
- CONNECTION, CONNECTED
- CONNECTION, DRAW OUT, DISCONNECTED
- CONNECTION, FEED FROM/TO
- CONNECTION, NOT CONNECTED
- CONNECTION, SPLICE
- CONTACT
- CURRENT TRANSFORMER
- DEAD BREAK ELBOW
- DRAW OUT FUSE AND POTENTIAL TRANSFORMER
- FUSE
- FUSED CUTOUT
- GROUND
- GROUND STUD
- INDUCTOR
- LIGHTNING ARRESTOR, GAP TYPE
- LIGHTNING ARRESTOR, MOV TYPE
- LOAD BREAK ELBOW
- POTENTIAL TRANSFORMER
- POTHEAD
- STRESS CONE
- SWITCH, FUSED LOAD BREAK
- SWITCH, NON-FUSED LOAD BREAK
- SWITCH, NON-FUSED DOUBLE LOAD BREAK
- SWITCH, NON-FUSED LOAD BREAK WITH GROUNDING POSITION
- RESISTOR
- TRANSFER SWITCH
- TRANSFORMER
- TRANSFORMER CONFIGURATION, DELTA
- TRANSFORMER CONFIGURATION, DELTA, OPEN

ELECTRICAL SCHEMATICS

Symbol	Description
	TRANSFORMER CONFIGURATION, DELTA, CORNER GROUND
	TRANSFORMER CONFIGURATION, WYE
	TRANSFORMER CONFIGURATION, WYE, SOLID GROUND
	TRANSFORMER CONFIGURATION, WYE, RESISTOR, GROUND
	TRANSFORMER CONFIGURATION, WYE, RESISTOR, CURRENT TRANSFORMER, GROUND
	TRANSFORMER CONFIGURATION, WYE, INDUCTOR, CURRENT TRANSFORMER, GROUND
	TRANSFORMER CONFIGURATION, ZIGZAG
	ZERO SEQUENCE CURRENT TRANSFORMER
50	RELAY, SINGLE FUNCTION
50/51	RELAY, DUAL FUNCTION
50 50 50 50 50 50	RELAY, MULTIFUNCTION
A	AMMETER
AS	AMPERAGE METER SWITCH
DMS	DIGITAL METERING SYSTEM
G	GENERATOR
K	KIRK KEY
LSIG	RELAY, TRIP UNIT
LSIG	DRAW OUT BREAKER C/W INTEGRAL SOLID STATE TRIP UNIT
LSIG	DRAW OUT BREAKER C/W SERIES ELECTROMECHANICAL TRIP UNIT
M	INLINE SOCKET METER
METER	METER
O/L	ELECTRONIC THERMAL OVERLOAD
SB	SHORTING BLOCK
SPACE	SPACE, DRAW OUT BREAKER
SPACE	SPACE, FIXED BREAKER
SPD	SURGE PROTECTION DEVICE
TS	TEST SWITCH
V	VOLTMETER
VS	VOLTAGE METER SWITCH
X	INDICATOR, VOLTAGE PRESENT

LUMINAIRES

CIRCUITS EMERGENCY	CIRCUITS NORMAL	Description
N/A	L01	LUMINAIRE IDENTIFICATION, SEE LUMINAIRES SCHEDULE
N/A	a	LOWER-CASE LETTER(S) NEAR LUMINAIRE DENOTE SWITCH LEG(S)
		RECESSED RECTANGULAR LUMINAIRE, DRAWN TO SCALE
		SURFACE MOUNTED RECTANGULAR LUMINAIRE, DRAWN TO SCALE
		RECESSED BASKET LUMINAIRE, DRAWN TO SCALE
		STRIP LUMINAIRE, LENGTH TO SCALE
		WALL MOUNTED RECTANGULAR LUMINAIRE, LENGTH TO SCALE(NUMBER OF MOUNTING POINTS WILL VARY WITH THE LUMINAIRE LENGTH AND ARE NOT INDICATED.)
		RECESSED DOWNLIGHT LUMINAIRE
		SURFACE MOUNTED DOWNLIGHT LUMINAIRE
		PENDANT MOUNTED LUMINAIRE
		LINEAR PENDANT MOUNTED LUMINAIRE, LENGTH TO SCALE (NUMBER OF MOUNTING POINTS WILL VARY WITH THE LUMINAIRE LENGTH AND ARE NOT INDICATED.)
		WALL MOUNTED LUMINAIRE
		WALL MOUNTED VERTICALLY ORIENTED LUMINAIRE
		WALL MOUNTED RECESSED LINEAR LUMINAIRE, LENGTH TO SCALE
	N/A	EXIT SIGN, FILLED SIDES INDICATE ILLUMINATED ANNOTATION, ARROWS INDICATE DIRECTIONAL GRAPHICS
	N/A	WALL MOUNTED EXIT SIGN, FILLED SIDES INDICATE ILLUMINATED ANNOTATION, ARROWS INDICATE DIRECTIONAL GRAPHICS
	N/A	EXIT SIGN WITH EMERGENCY BATTERY PACK
	N/A	WALL MOUNTED EXIT SIGN WITH EMERGENCY BATTERY PACK
	N/A	EMERGENCY BATTERY PACK, NUMBER OF LAMPS NOT INDICATED
	N/A	WALL MOUNTED EMERGENCY BATTERY PACK, NUMBER OF LAMPS NOT INDICATED
	N/A	EMERGENCY WITH REMOTE BATTERY PACK, NUMBER OF LAMPS NOT INDICATED
	N/A	WALL MOUNTED EMERGENCY WITH REMOTE BATTERY PACK, NUMBER OF LAMPS NOT INDICATED
		RECESSED LINEAR WALL WASH LUMINAIRE, LENGTH TO SCALE
		RECESSED WALL WASH LUMINAIRE
		SURFACE MOUNTED WALL WASH LUMINAIRE
		RECESSED ACCENT LUMINAIRE
		SURFACE MOUNTED ACCENT LUMINAIRE
		PENDANT MOUNTED ACCENT LUMINAIRE
		MONOPOINT LUMINAIRE
N/A		TRACK LIGHTING
N/A		CONTINUOUS SOURCE LUMINAIRE, PATH AS INDICATED
		MULTI-LAMP ACCENT LUMINAIRE, NUMBER OF LAMPS NOT INDICATED
		WALL MOUNTED MULTI-LAMP ACCENT LUMINAIRE, NUMBER OF LAMPS NOT INDICATED
		OVERCOUNTER TASK LUMINAIRE
		UNDERCOUNTER TASK LUMINAIRE
		FIBER OPTIC REMOTE SOURCE
		STEP LUMINAIRE
		ILLUMINATED SIGN
		WALL MOUNTED ILLUMINATED SIGN
		NIGHT LIGHT

LIGHTING CONTROLS

Symbol	Description
$	SINGLE POLE SWITCH
	INDICATES WIRELESS CONTROL
$a	LOWER-CASE LETTER(S) NEAR SWITCH DENOTE SWITCH LEG(S)
$2	DOUBLE POLE SWITCH
$3	THREE-WAY SWITCH
$4	FOUR-WAY SWITCH
$D	DIMMER SWITCH
$K	KEY OPERATED SWITCH
$LV	MOMENTARY CONTACT LOW VOLTAGE SWITCH
$O	OCCUPANCY SENSOR SWITCH
$OD	OCCUPANCY SENSOR/DIMMER SWITCH
$P	SWITCH WITH PILOT LIGHT
$PC	PHOTOCELL SWITCH
$T	TIMER SWITCH
CS#	LOW VOLTAGE CONTROL STATION, # INDICATES STATION IDENTIFICATION
DSC	DIMMING SYSTEM CONTROL PANEL
J ELCU	EMERGENCY LIGHTING CONTROL UNIT
LCP	LIGHTING CONTROL PANEL
OS	OCCUPANCY SENSOR SWITCH, CEILING MOUNTED
PS	PHOTO SENSOR CONTROL
PS	PHOTO SENSOR CONTROL, CEILING MOUNTED
DH	DAYLIGHT HARVESTING SENSOR
DH	DAYLIGHT HARVESTING SENSOR, CEILING MOUNTED
R	RELAY
T	LOW VOLTAGE TRANSFORMER

SITE/LANDSCAPE/GARAGE LUMINAIRES

CIRCUITS: EMERGENCY, NORMAL

- LIGHTING STANDARD: LUMINAIRE, POLE, AND BASE
- LAMP POST
- ILLUMINATED BOLLARD
- IN-GROUND LUMINAIRE
- ADJUSTABLE IN-GROUND LUMINAIRE
- SURFACE MOUNTED GARAGE LUMINAIRE
- SURFACE MOUNTED SHIELDED GARAGE LUMINAIRE, LINES INDICATE NUMBER AND POSITION OF SHIELD(S)

CLOCK SYSTEMS

Symbol	Description
	CLOCK, 12 HOUR DIAL
24	CLOCK, 24 HOUR DIAL
D	CLOCK, DIGITAL
	ELAPSED TIME CLOCK
ETC	ELAPSED TIME CONTROLLER

DOOR BUZZERS

Symbol	Description
	PUSH BUTTON
B	BUZZER HORN
B	BUZZER HORN AND VISUAL INDICATOR

SITE UTILITIES

Symbol	Description
	GROUND ROD
HH	HANDHOLE
M	SITE METER
MH	MANHOLE
PB	PULL BOX
PMH	PRIMARY MANHOLE
SMH	SECONDARY MANHOLE
TMH	TELECOMMUNICATIONS MANHOLE

SITE UTILITY POLES

- CATV ONLY
- COMBINED SERVICES
- POWER ONLY
- RISER
- TELECOM ONLY
- STEPDOWN TRANSFORMER, POLE MOUNTED

ELECTRICAL EQUIPMENT

Symbol	Description
	208V OR 240V POWER PANELBOARD
	480V OR 600V POWER PANELBOARD
	EQUIPMENT CABINET OR PANEL
	EQUIPMENT CONNECTION, FILL INDICATES EMERGENCY CIRCUIT
	GROUND BAR
	MOTOR CONNECTION, 1Ø
	MOTOR CONNECTION, 3Ø
	BUS DUCT
ATS	AUTOMATIC TRANSFER SWITCH
B	BUS DUCT PLUG
SPD	SURGE PROTECTIVE DEVICE
T	TRANSFORMER, LESS THAN 30KVA, NOT TO SCALE
	TRANSFORMER, 30KVA OR GREATER, DRAWN TO SCALE

CIRCUITS

Symbol	Description
	RACEWAY CONCEALED IN CEILING OR WALL. EXPOSED RACEWAY IS ALLOWED ONLY WHERE NOTED.
	RACEWAY BELOW SLAB OR UNDERGROUND
	RACEWAY UP
	RACEWAY DOWN
	RACEWAY CONTINUATION
	RACEWAY STUB-OUT WITH BUSHING
J	JUNCTION BOX, CEILING OR ABOVE CEILING MOUNTED
J	JUNCTION BOX, WALL MOUNTED
PB	PULL BOX

RECEPTACLES

CIRCUITS EMERGENCY	CIRCUITS NORMAL	Description
		SINGLE RECEPTACLE, 120V
		SINGLE RECEPTACLE, CEILING MOUNTED
		DUPLEX RECEPTACLE, 120V
		DUPLEX RECEPTACLE, CEILING MOUNTED
		DOUBLE DUPLEX RECEPTACLE, 120V
		DOUBLE DUPLEX RECEPTACLE, CEILING MOUNTED
		SPLIT WIRED RECEPTACLE, 120V, TOP SWITCHED
#	#	RECEPTACLE, NEMA #
#	#	COMBINATION RECEPTACLE, 120V AND NEMA #
		FURNITURE SYSTEMS RECEPTACLE, 120V
N/A		INDICATES CONTROLLED
N/A		INDICATES 15A
N/A		INDICATES TWIST LOCK
N/A	FB#	MULTI-SERVICE FLOOR BOX (REFER TO SCHEDULE ON E502)
N/A	PT#	MULTI-SERVICE POKE THRU (REFER TO SCHEDULE ON E502)
N/A		MULTI-SERVICE POWER POLE (RECEPTACLES/OUTLETS AS INDICATED)
N/A		MULTI-SERVICE ASSEMBLY (RECEPTACLES/OUTLETS AS INDICATED)
N/A		CLOCK RECEPTACLE, 120V
		CEILING CORD DROP, 120V

RECEPTACLE TYPES

Symbol	Description
	MOUNTED 3" ABOVE COUNTER BACKSPLASH
D	DEDICATED CIRCUIT
G	GROUND FAULT CIRCUIT INTERRUPTER
GT	GROUND FAULT CIRCUIT INTERRUPTER AND TAMPER RESISTANT
IG	ISOLATED GROUND
S	SURGE PROTECTOR
T	TAMPER RESISTANT
U	INTEGRAL USB PORT(S)
WP	GROUND FAULT CIRCUIT INTERRUPTER WITH WEATHER RESISTANT COVER

ELECTRICAL CONTROLS

Symbol	Description
	NON-FUSED SAFETY SWITCH
	FUSED SAFETY SWITCH, FUSE RATING INDICATED
	COMBINATION MOTOR STARTER AND FUSED SAFETY SWITCH, FUSE RATING INDICATED
	MOTOR STARTER
	MANUAL MOTOR STARTER
	AUTOMATIC DOOR PUSHPLATE
	EMERGENCY SHUTDOWN
	ENCLOSED CIRCUIT BREAKER
C	CONTACTOR
	PUSH BUTTON CONTROL STATION
$	POWER SWITCH, MOTOR RATED
$K	POWER SWITCH, MOTOR RATED (KEYED)
DDC	DIRECT DIGITAL CONTROL PANEL
R	RELAY
T	THERMOSTAT
TC	TIME CLOCK
VFD	VARIABLE FREQUENCY DRIVE

WE RECYCLE
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BLACK
WHITE

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ELECTRICAL SYMBOLS AND ABBREVIATIONS

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0179
DATE: 11-NOV-2022
SHEET
E-002
CONSTRUCTION DOCUMENTS

2 ENLARGED DEMO PLAN - ELEC 119
ED-111 1/4" = 1'-0"

FIRST LEVEL ELECTRICAL DEMOLITION PLAN - AREA A
1/8" = 1'-0"

ELECTRICAL DEMOLITION GENERAL NOTES

1. REFER TO DRAWING E001 AND E002 FOR LEGEND, ABBREVIATIONS AND GENERAL NOTES.
2. ALL ELECTRICAL ITEMS BEING REMOVED SHALL BE LEGALLY DISPOSED OF OFF-SITE UNLESS DIRECTED OTHERWISE BY OWNER.
3. ALL ELECTRICAL OUTLETS, DEVICES, CONDUIT AND WIRING, ETC., SHOWN CROSS HATCHED SHALL BE REMOVED BACK TO SOURCE OR UPSTREAM JUNCTION BOX.
4. CONTRACTOR SHALL NOT ABANDON EXISTING WIRING WITHIN EXISTING WALLS OR CEILINGS TO REMAIN. ALL SUCH ELECTRICAL ITEMS SHALL BE REMOVED.
5. MAINTAIN OPERATION OF ALL EXISTING SYSTEMS DURING CONSTRUCTION. ANY REQUIRED SHUTDOWNS SHALL BE COORDINATED WITH THE OWNER.
6. 'R' INDICATES EXISTING EQUIPMENT TO BE RELOCATED. CAREFULLY DISCONNECT AND STORE IN A SAFE PLACE UNTIL RE-INSTALLATION.
7. WHERE SAWCUTTING IS NOTED, ELECTRICAL CONTRACTOR SHALL PROVIDE COST TO PROVIDE XRAY/GPR TO LOCATE CONDUITS IN SLAB.
8. EXISTING CIRCUIT NUMBERS INDICATED ARE FOR INFORMATION WHICH SHOULD BE VERIFIED PRIOR TO WORK.

ELECTRICAL DEMOLITION KEYNOTES

#	KEY NOTES
ED1	EXISTING POLE MOUNTED TRANSFORMER TO BE REMOVED BY LANSING BOARD OF WATER & LIGHT (BWL). CONTRACTOR TO REMOVE EXISTING OVERHEAD SERVICE DROP.
ED2	EXISTING UNDERGROUND ELECTRICAL SECONDARY CONDUCTORS TO BE REMOVED. ABANDON UNDERGROUND CONDUIT.
ED3	EXISTING HORIZONTAL UNIT VENTILATOR TO BE REMOVED AND REPLACED. RESERVE AND PROTECT CIRCUIT IN PLACE TO BE USED FOR POWER TO NEW UNIT.

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FIRST LEVEL ELECTRICAL DEMOLITION PLAN

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WHITE

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CHECKED BY: Checker APPROVED BY: Approver

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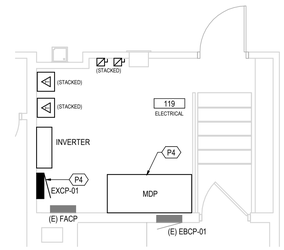
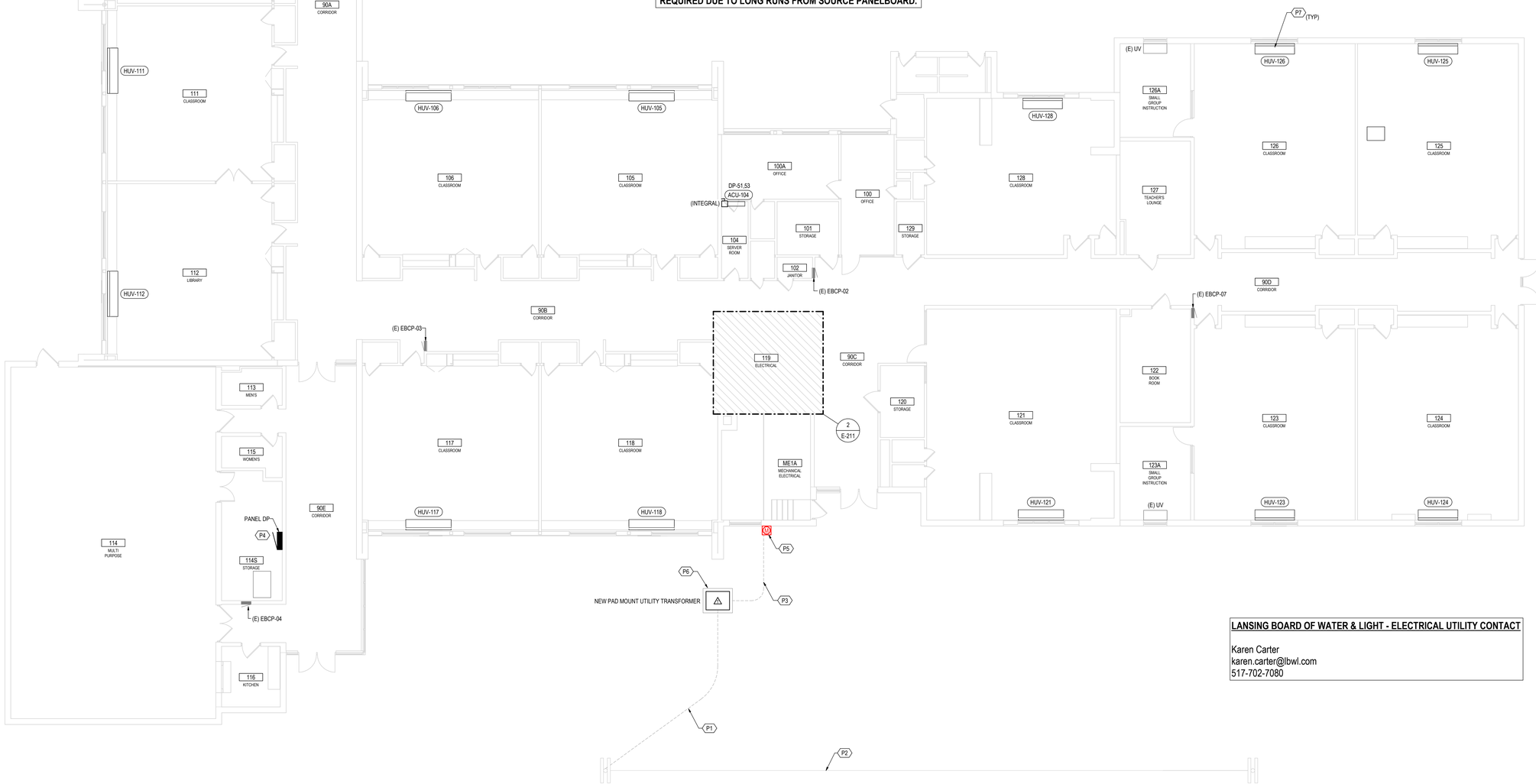
WHITE



2 E-211 **ENLARGED PLAN - ELEC 119**
1/4" = 1'-0"

CONTRACTOR SHALL UPSIZE WIRING FOR VOLTAGE DROP AS REQUIRED DUE TO LONG RUNS FROM SOURCE PANELBOARD.



LANSING BOARD OF WATER & LIGHT - ELECTRICAL UTILITY CONTACT

Karen Carter
karen.carter@lbwl.com
517-702-7080

POWER & AUXILIARY GENERAL NOTES

1. REFER TO DRAWING E001 AND E002 FOR ELECTRICAL LEGEND AND ABBREVIATIONS.
2. REFER TO DRAWING E401 FOR ELECTRICAL SINGLE LINE DIAGRAM.
3. EACH CIRCUIT SHALL HAVE A DEDICATED NEUTRAL CONNECTED BACK TO THE PANEL.
4. COORDINATE ALL DEVICE MOUNTING LOCATIONS, HEIGHTS, AND SPACINGS WITH ARCHITECTURAL FLOOR PLANS AND ELEVATIONS. BIDDERS SHALL EXAMINE ARCHITECTURAL DRAWINGS TO INCLUDE ANY NECESSARY COSTS WITH HIS BID.
5. IN GENERAL, DEVICES AT LOWER HEIGHTS SHALL BE STACKED DIRECTLY BELOW DEVICES AT HIGHER ELEVATIONS. PROVIDE CONDUIT OFFSET AS NECESSARY.
6. COORDINATE MOUNTING HEIGHT OF DEVICES ABOVE MILLWORK WITH ARCHITECTURAL PLANS.
7. COORDINATE FINAL MOUNTING HEIGHT OF ELECTRICAL DEVICES FOR UNIT APPLIANCES WITH MANUFACTURER'S INSTALLATION INSTRUCTIONS PRIOR TO ROUGH-IN.
8. SWITCHES AND RECEPTACLES INSTALLED ABOVE COUNTERTOPS SHALL BE THE SAME HEIGHT.
9. REFER TO STRUCTURAL DRAWINGS FOR PENETRATION REQUIREMENTS THROUGH EXISTING STRUCTURAL ELEMENTS.

POWER & AUXILIARY KEYNOTES

#	KEY NOTES
P1	PROVIDE (2) 4" EMPTY CONDUIT BELOW GRADE WITH PULL STRING FOR UNDERGROUND PRIMARY ELECTRICAL SERVICE ENTRANCE FEEDERS. STUB UP AND CAP AT POWER POLE OR AS DIRECTED BY POWER COMPANY. COORDINATE ROUTING OF CONDUIT WITH POWER COMPANY AND EASEMENT LOCATION. COORDINATE REQUIREMENTS FOR PULL BOXES WITH POWER COMPANY AND PROVIDE AS REQUIRED.
P2	LANSING BOARD OF WATER & LIGHT TO EXTEND OVERHEAD PRIMARY TO EXISTING POLE AND ROUTE BELOW GRADE TO NEW PAD MOUNTED TRANSFORMER.
P3	ROUTE SECONDARY ELECTRICAL SERVICE ENTRANCE FEEDERS UNDERGROUND AND STUB UP TO UTILITY METER AT BUILDING EXTERIOR. PENETRATE THROUGH EXTERIOR WALL AND ROUTE CONCRETE ENCASED CONDUIT ABOVE GRADE IN MECHANICAL/ELECTRICAL ME1A ROOM PER N.E.C. 230.6. COORDINATE FINAL CONDUIT ROUTING INSIDE BOILER ROOM SPACE WITH ALL ELEMENTS (EQUIPMENT, PIPING, DUCTWORK, ETC.) IN FIELD.
P4	MAINTAIN MINIMUM 3 FEET WORKING SPACE CLEARANCE IN FRONT OF NEW DISTRIBUTION PANELBOARD.
P5	NEW CT CABINET AND METER SOCKET PROVIDED BY LANSING BOARD OF WATER AND LIGHT.
P6	LOCATION FOR UTILITY TRANSFORMER IS APPROXIMATE. COORDINATE FINAL LOCATION WITH LANSING BOARD OF WATER AND LIGHT. REFER TO DRAWING E501 FOR PAD REQUIREMENTS.
P7	EXISTING HORIZONTAL UNIT VENTILATOR REMOVED AND REPLACED WITH NEW. PROVIDE POWER TO NEW UNIT USING EXISTING CIRCUIT.

FIRST LEVEL POWER & AUXILIARY PLAN
1/8" = 1'-0"

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FIRST LEVEL POWER & AUXILIARY PLAN

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THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK
WHITE

POWER & AUXILIARY GENERAL NOTES

1. REFER TO DRAWING E001 AND E002 FOR ELECTRICAL LEGEND AND ABBREVIATIONS.
2. REFER TO DRAWING E401 FOR ELECTRICAL SINGLE LINE DIAGRAM.
3. EACH CIRCUIT SHALL HAVE A DEDICATED NEUTRAL CONNECTED BACK TO THE PANEL.
4. COORDINATE ALL DEVICE MOUNTING LOCATIONS, HEIGHTS, AND SPACINGS WITH ARCHITECTURAL FLOOR PLANS AND ELEVATIONS. BIDDERS SHALL EXAMINE ARCHITECTURAL DRAWINGS TO INCLUDE ANY NECESSARY COSTS WITH HIS BID.
5. IN GENERAL, DEVICES AT LOWER HEIGHTS SHALL BE STACKED DIRECTLY BELOW DEVICES AT HIGHER ELEVATIONS. PROVIDE CONDUIT OFFSET AS NECESSARY.
6. COORDINATE MOUNTING HEIGHT OF DEVICES ABOVE MILLWORK WITH ARCHITECTURAL PLANS.
7. COORDINATE FINAL MOUNTING HEIGHT OF ELECTRICAL DEVICES FOR UNIT APPLIANCES WITH MANUFACTURER'S INSTALLATION INSTRUCTIONS PRIOR TO ROUGH-IN.
8. SWITCHES AND RECEPTACLES INSTALLED ABOVE COUNTERTOPS SHALL BE THE SAME HEIGHT.
9. REFER TO STRUCTURAL DRAWINGS FOR PENETRATION REQUIREMENTS THROUGH EXISTING STRUCTURAL ELEMENTS.

PROVIDE UNISTRUT REQUIRED TO MOUNT ROOFTOP ELECTRICAL DEVICES AND EQUIPMENT INDEPENDENT OF MECHANICAL UNITS. REFER TO DRAWING E501 FOR ADDITIONAL REQUIREMENTS.

DP-50 WP
DP-19,21,23 60 AF 35 AT/3P (ACCU-109)
DP-13,15,17 60 AF 35 AT/3P (ACCU-108)
DP-50 WP
DP-25,27,29 30 AF 30 AT/3P (ACCU-110)
DP-31,33,35 30 AF 30 AT/3P (ACCU-111)
DP-32,34,36 30 AF 25 AT/3P (ACCU-126)
DP-52 WP
DP-26,28,30 30 AF 25 AT/3P (ACCU-125)
DP-52 WP
DP-38,40,42 30 AF 25 AT/3P (ACCU-128)
DP-7,9,11 30 AF 30 AT/3P (ACCU-106)
DP-52 WP
DP-1,3,5 30 AF 30 AT/3P (ACCU-105)
DP-44,46 (INTEGRAL) (ACU-1)
DP-37,39,41 30 AF 30 AT/3P (ACCU-112)
DP-50 WP
DP-43,45,47 30 AF 30 AT/3P (ACCU-117)
DP-2,4,6 30 AF 30 AT/3P (ACCU-118)
DP-52 WP
DP-8,10,12 30 AF 30 AT/3P (ACCU-121)
DP-14,16,18 30 AF 25 AT/3P (ACCU-123)
DP-52 WP
DP-20,22,24 30 AF 25 AT/3P (ACCU-124)
WORK IN THIS AREA PART OF ALTERNATE #1
DP-50 WP
DP-49 30 AF 25 AT/1P (MAU-1)
(INTEGRAL) DP-48 (EF-1)

ROOF LEVEL POWER & AUXILIARY PLAN
1/8" = 1'-0"

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BLACK
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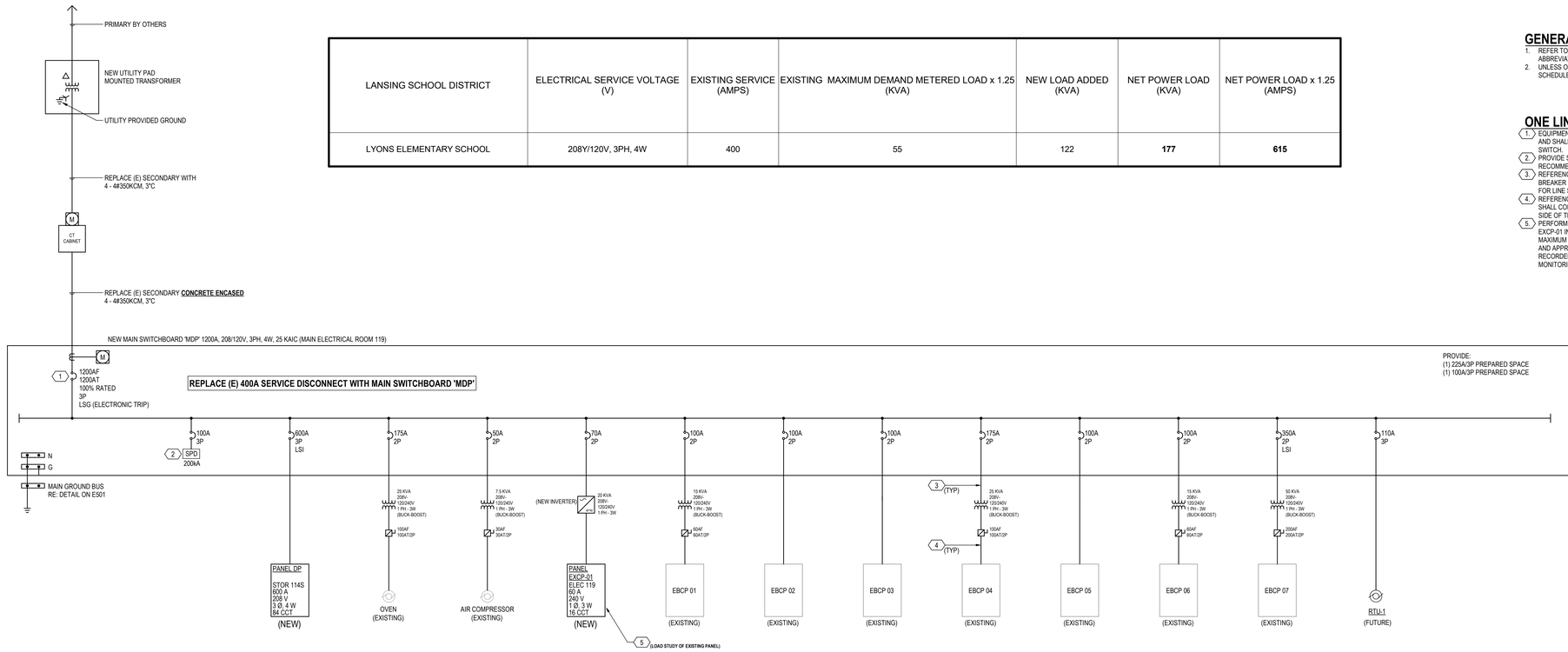
LANSING SCHOOL DISTRICT	ELECTRICAL SERVICE VOLTAGE (V)	EXISTING SERVICE (AMPS)	EXISTING MAXIMUM DEMAND METERED LOAD x 1.25 (KVA)	NEW LOAD ADDED (KVA)	NET POWER LOAD (KVA)	NET POWER LOAD x 1.25 (AMPS)
LYONS ELEMENTARY SCHOOL	208Y/120V, 3PH, 4W	400	55	122	**177**	**615**

GENERAL NOTES

1. REFER TO DRAWING E001 AND E002 FOR ELECTRICAL LEGEND AND ABBREVIATIONS.
2. UNLESS OTHERWISE NOTED, USE THE FEEDER AND BRANCH CIRCUIT SIZING SCHEDULE FOR FEEDER SIZES.

ONE LINE DIGRAM KEY NOTES

1. EQUIPMENT SHALL COMPLY WITH 2017 NEC 240.87 ARC ENERGY REDUCTION AND SHALL UTILIZE AN ENERGY REDUCTION MAINTENANCE SETTING (ERMS) SWITCH.
2. PROVIDE SPD INTERNALLY MOUNTED PER MANUFACTURER'S RECOMMENDATION.
3. REFERENCE SCHEDULE ON THIS SHEET FOR FEEDER SIZING. CIRCUIT BREAKER SHALL CORRESPOND TO NOMINAL CIRCUIT RATING IN SCHEDULE FOR LINE SIDE OF TRANSFORMER/INVERTER.
4. REFERENCE SCHEDULE ON THIS SHEET FOR FEEDER SIZING. FUSE RATING SHALL CORRESPOND TO NOMINAL CIRCUIT RATING IN SCHEDULE FOR LOAD SIDE OF TRANSFORMER/INVERTER.
5. PERFORM A 30-DAY LOAD STUDY ON EACH PHASE FOR EXISTING PANEL EXCP-01 IN ACCORDANCE WITH NEC 220.87 TO DETERMINE THE EXISTING MAXIMUM DEMAND. SUBMIT THE RESULTS TO THE ENGINEER FOR REVIEW AND APPROVAL. THE REPORT SHALL CONTAIN PEAK DEMAND VALUES RECORDED AT 15-MINUTE INTERVALS OVER THE DURATION OF THE 30-DAY MONITORING PERIOD.



ELECTRICAL ONE LINE DIAGRAM
SCALE: NONE

Stantec — Panel

Name: **DP** — Volts: 208Y/120V — Mains Type: MLO — Type:
Location: STORAGE 114S — Phases: 3 — Mains Rating: 600 A — AIC Rating: 22000
Supply From: MDP — Wires: 4 — Max Rating: 600 A — Mounting: Surface
Serves: — Lugs: Single Lugs — Enclosure: Type 1

Notes:
PROVIDE (1) INGEGRAL SURGE PROTECTIVE DEVICE, 100kA SPD SERIES - STANDARD w/SURGE COUNTER, WITH FUSIBLE DISCONNECT

CKT	Circuit Description	Trip	Poles	CB	A		B		C		CB	Poles	Trip	Circuit Description	CKT
1	ACCU-105	30 A	3		2438	2438						3	30 A	ACCU-118	2
3	--	--	--	--			2438	2438			--	--	--	--	4
5	--	--	--	--					2438	2438	--	--	--	--	6
7	ACCU-106	30 A	3		2438	2438						3	30 A	ACCU-121	8
9	--	--	--	--			2438	2438			--	--	--	--	10
11	--	--	--	--					2438	2438	--	--	--	--	12
13	ACCU-108	35 A	3		2690	1945						3	25 A	ACCU-123	14
15	--	--	--	--			2690	1945			--	--	--	--	16
17	--	--	--	--					2690	1945	--	--	--	--	18
19	ACCU-109	35 A	3		2690	1945						3	25 A	ACCU-124	20
21	--	--	--	--			2690	1945			--	--	--	--	22
23	--	--	--	--					2690	1945	--	--	--	--	24
25	ACCU-110	30 A	3		2438	1945						3	25 A	ACCU-125	26
27	--	--	--	--			2438	1945			--	--	--	--	28
29	--	--	--	--					2438	1945	--	--	--	--	30
31	ACCU-111	30 A	3		2438	1945						3	25 A	ACCU-126	32
33	--	--	--	--			2438	1945			--	--	--	--	34
35	--	--	--	--					2438	1945	--	--	--	--	36
37	ACCU-112	30 A	3		2438	1945						3	25 A	ACCU-128	38
39	--	--	--	--			2438	1945			--	--	--	--	40
41	--	--	--	--					2438	1945	--	--	--	--	42
43	ACCU-117	30 A	3		2438	1144						2	30 A	ACU-1	44
45	--	--	--	--			2438	1144			--	--	--	--	46
47	--	--	--	--					2438	864		1	20 A	EF-1	48
49	MAU-1	25 A	1		2040	720						1	20 A	ROOFTOP WP MAINT RECEPTACLES	50
51	ACU-104 SERVER ROOM 104	20 A	2				250	900				1	20 A	ROOFTOP WP MAINT RECEPTACLES	52
53	--	--	--	--					250	0	--	1	20 A	SPARE	54
55	SPARE	20 A	1	--	0	0					--	1	20 A	SPARE	56
57	SPARE	20 A	1	--			0	0			--	1	20 A	SPARE	58
59	SPARE	20 A	1	--					0	0	--	1	20 A	SPARE	60
61	SPARE	20 A	1	--	0	0					--	1	20 A	SPARE	62
				Total Load:	38.51 kVA		36.90 kVA		35.55 kVA						
				Total Amps:	323 A		309 A		296 A						

Load Classification	Connected Load	Demand Factor	Estimated Demand	Panel Totals
HVAC	108657 VA	100.00%	108657 VA	
Motor	864 VA	125.00%	1080 VA	**Total Conn. Load: 110969 VA**
Receptacle	1620 VA	100.00%	1620 VA	**Total Est. Demand: 111143 VA**
				Total Conn.: 308 A
				Total Est. Demand: 309 A

CB Legend (blank = circuit breaker):
G = GFCI S = Shunt Trip D = Switching Duty A = AFCI H = HID Rated C = HACR Rated † = Existing Circuit ‡ = Revised Circuit

Notes:

Stantec

Name: EXCP-01 — Volts: 120/240 — Mains Type: MLO — Type:
Location: ELECTRICAL RM 119 — Phases: 1 — Main Bus Rating: 100 A — A.I.C. Rating: 22 kA
Supply From: SWITCHBOARD 'MDP' — Wires: 3 — Max Rating: 100 A — Mounting: Surface
Serves: — Lugs: NA — Enclosure: Type 1

Notes:

CKT	Circuit Description	Trip	Poles	CB	A		B		CB	Poles	Trip	Circuit Description	CKT
1	MAIN DISCONNECT	60A	2	--	--	--			--	2	20A	FIRE ALARM	2
3	--		--	--			--	--	--	--	--	--	4
5	HEATING COILS	20A	1	--	--	--			--	1	20A	CLASSROOM CLOCKS	6
7	GYM EMERGENCY LTG	20A	1	--			--	--	--	1	20A	EXIT SIGNS	8
9	MASTER CLOCK	20A	1	--	--	--			--	1	20A	EXIT SIGNS	10
11	TELEPHONE	20A	1	--			--	--	--	1	20A	INTERCOM	12
13	LAMINATING MACHINE	20A	1	--	--	--			--	1	20A	COPY MACHINE	14
15	UPS SERVER ROOM 104	20A	1	--			--	--	--	1	30A	UPS SERVER ROOM 104	16
				Total Load:	-- kVA		-- kVA						
				Total Amps:	-- Amps		-- Amps						

Load Classification	Connected Load	Demand Factor	Estimated Demand	Panel Totals
Lighting (L)	--	100%	--	
Power (P)	--	100%	--	**Total Connected Load: --**
Receptacle (R)	--	100%	--	**Total Connected Load: --**
Kitchen (K)	--	100%	--	**Total Est. Demand: --**
HVAC (H)	--	100%	--	**Total Est. Demand: --**
A/C (A)	--	100%	--	
Power Equipment (E)	--	100%	--	

CB Legend (blank = circuit breaker):
G = GFCI S = Shunt Trip D = Switching Duty A = AFCI H = HID Rated C = HACR Rated † = Existing Circuit ‡ = Revised Circuit

Notes:

COPPER FEEDERS

ID	NOMINAL CIRCUIT RATING	SETS	CONDUCTORS	GROUND	CONDUIT W/ N (4W)	CONDUIT W/O N (3W)
C01	20	1	#12	#12	3/4"	3/4"
C02	30	1	#10	#10	3/4"	3/4"
C03	40	1	#8	#10	3/4"	3/4"
C04	50	1	#6	#10	1"	3/4"
C05	60	1	#4	#10	1 1/4"	1"
C06	70	1	#4	#8	1 1/4"	1 1/4"
C07	80	1	#3	#8	1 1/4"	1 1/4"
C08	90	1	#2	#8	1 1/2"	1 1/4"
C09	100	1	#1	#8	1 1/2"	1 1/2"
C10	125	1	#1	#6	1 1/2"	1 1/2"
C11	150	1	#1/0	#6	2"	1 1/2"
C12	175	1	#2/0	#6	2"	2"
C13	200	1	#3/0	#6	2"	2"
C14	225	1	#4/0	#4	2 1/2"	2"
C15	250	1	250 kcmil	#4	3"	2 1/2"
C16	300	1	350 kcmil	#4	3"	2 1/2"
C17	350	1	500 kcmil	#3	3 1/2"	3"
C18	400	1	500 kcmil	#3	3 1/2"	3"
C19	450	2	#4/0	#2	2 1/2"	2"
C20	500	2	250 kcmil	#2	3"	2 1/2"
C21	600	2	350 kcmil	#1	3"	2 1/2"
C22	800	2	500 kcmil	#1/0	3 1/2"	3"
C23	900	3	350 kcmil	#2/0	3"	3"
C24	1000	3	500 kcmil	#2/0	3 1/2"	3"
C25	1200	4	350 kcmil	#3/0	3"	3"
C26	1600	5	500 kcmil	#4/0	3 1/2"	3"
C27	2000	6	500 kcmil	250 kcmil	3 1/2"	3"
C28	2500	7	500 kcmil	350 kcmil	3 1/2"	3 1/2"
C29	3000	8	500 kcmil	500 kcmil	4"	3 1/2"
C30	4000	11	500 kcmil	500 kcmil	4"	3 1/2"

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ELECTRICAL SINGLE LINE DIAGRAM

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0179
DATE: 11-NOV-2022
SHEET
E-401

CONSTRUCTION DOCUMENTS

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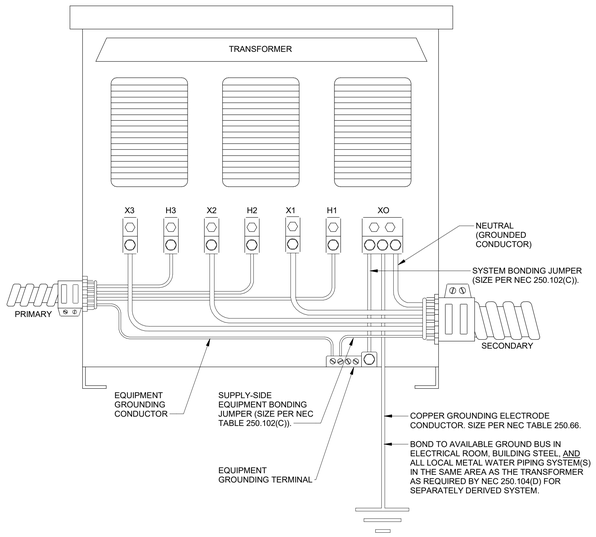
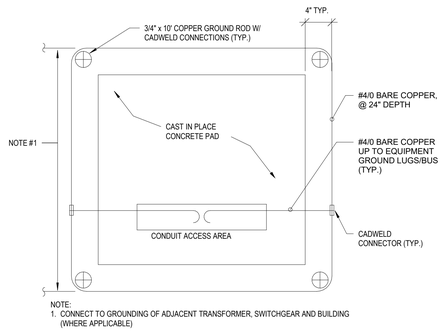
Autodesk Docs://LSD - Lyonselm_elec_24410065_Lyons_R22.rvt
DESIGNED BY: Designer
CHECKED BY: Checker APPROVED BY: Approver

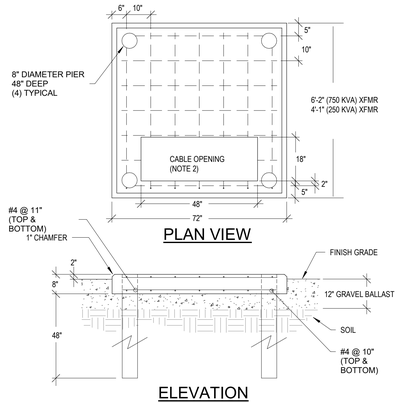
WE RECYCLE
THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK
WHITE
BLACK



TRANSFORMER SYSTEM BONDING DETAIL
SCALE: NONE

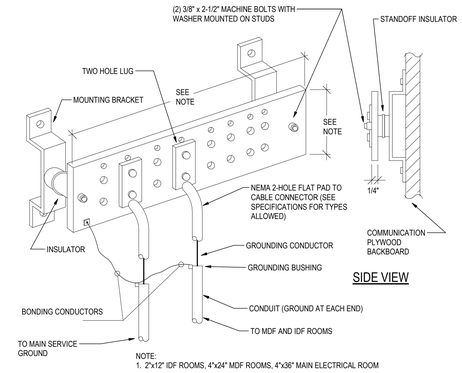


TRANSFORMER GROUNDING PLAN (TYP)
SCALE: NONE



NOTES:
1. EXTEND PAD 4" BEYOND ENCLOSURE AND COOLING FIN OF TRANSFORMER.
2. VERIFY ACTUAL DIMENSIONS OF TRANSFORMERS AND GENERATOR CABLE OPENINGS.

TRANSFORMERS PAD DETAIL (TYP.)
SCALE: NONE



GROUND BUS DETAIL
SCALE: NONE

DANGER

Arc Flash & Shock Hazard
Appropriate PPE Required

Flash Hazard Category _____
Incident Energy (cal/cm²) _____
VAC Shock Hazard When: _____

Flash Protection Boundary _____
Limited Approach Boundary _____
Protection Approach Boundary _____
Prohibited Approach Boundary _____

FLASH PPE			SHOCK PPE	
☐ Long sleeve shirt	☐ FR coverall	☐ Hearing protection	☐	☐ Class _____
☐ Long pants	☐ Flash suit	☐ Safety glasses	☐	☐ V-rating _____
☐ FR shirt	☐ Flash hood	☐ Safety goggles	☐	☐
☐ FR pants	☐ Hard hat	☐ Leather gloves	☐	☐
	☐ Face shield	☐ Leather shoes	☐	☐

Equipment ID:

PROVIDE A 4"x6" RED LABEL ON THE OUTSIDE OF PANELS IN AREAS OPEN ONLY TO "QUALIFIED PERSONNEL" AND ON THE INSIDE PANEL DOOR OF PANELS IN "OCCUPANT AREAS". BRADY #99459 OR APPROVED EQUIVALENT.

WARNING

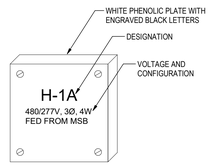
Arc Flash Hazard
Appropriate PPE Required

DO NOT OPERATE CONTROLS OR OPEN COVERS WITHOUT APPROPRIATE PERSONAL PROTECTION EQUIPMENT.
FAILURE TO COMPLY MAY RESULT IN INJURY OR DEATH!

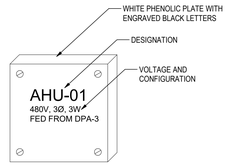
Refer to NFPA 70E for minimum PPE requirements

PROVIDE A 3"x5" YELLOW LABEL ON THE OUTSIDE OF PANELS IN "OCCUPANT AREAS". BRADY #99454 OR APPROVED EQUIVALENT.

TYPICAL ARC FLASH WARNING LABELS
SCALE: NONE



PANELBOARD

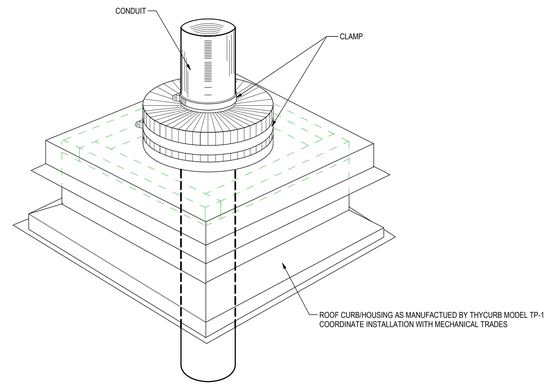


MECHANICAL UNIT

TRANSFORMER

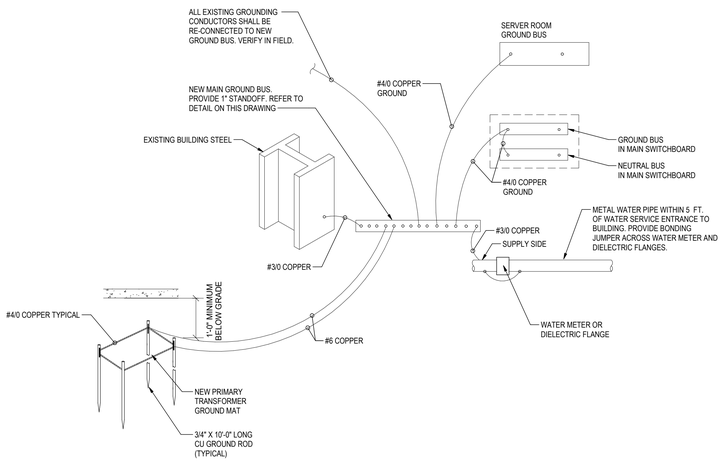
NOTE:
ATTACH SECURELY WITH STAINLESS STEEL SCREW. NON-CORROSIVE POP RIVETS ARE ACCEPTABLE, ADHESIVE ATTACHEMENT IS NOT ACCEPTABLE.

EQUIPMENT IDENTIFICATION
SCALE: NONE

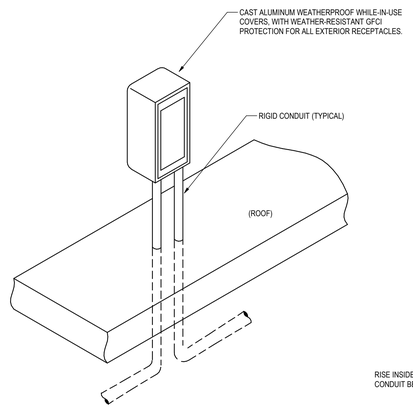


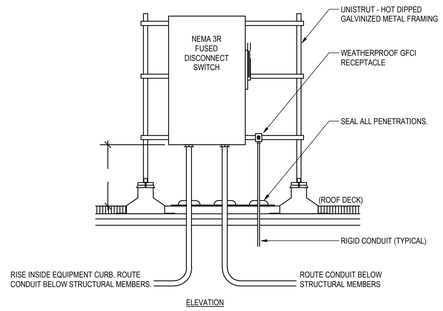
NOTES:
1. ELECTRICAL CONTRACTOR SHALL SUBCONTRACT BUILDING ROOF CONTRACTOR FOR INSTALLATION OF FLASHING.

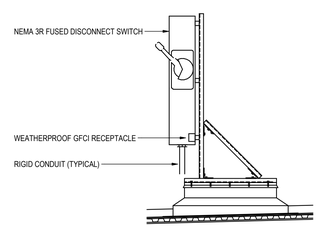
CONDUIT ROOF PENETRATION DETAIL
SCALE: NONE



GROUNDING SYSTEM DETAIL
SCALE: NONE







ROOF MOUNTED RECEPTACLE/SWITCH RACK DETAIL
SCALE: NONE

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ELECTRICAL DETAILS

REVISIONS

REV	DESCRIPTION	DATE

PROJ. #: 22-0179
DATE: 11-NOV-2022
SHEET
E-501

CONSTRUCTION DOCUMENTS

11/11/2022 12:40:34 PM
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DESIGNED BY: Designer
CHECKED BY: Checker APPROVED BY: Approver