



HARRIMAN

Dorothea Dix
Building K Ventilation Upgrades
Bangor, Maine

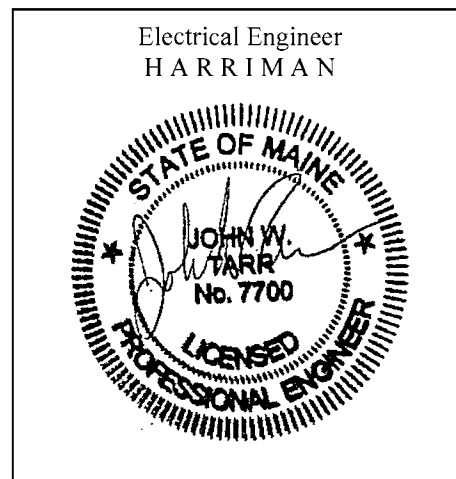
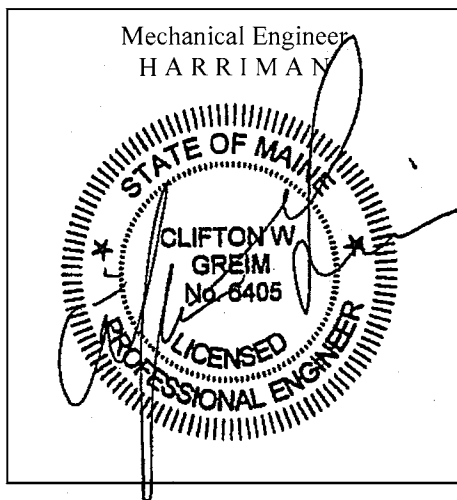
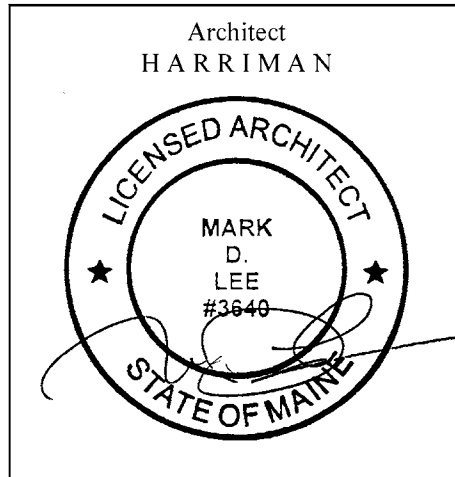
Project No. 18421

April 19, 2019

Construction Documents

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PROFESSIONAL SEAL PAGE



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**DOROTHEA DIX
BUILDING K VENTILATION UPGRADES
BANGOR, MAINE**

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00 11 13
Notice to Contractors

Dorothea Dix Building K Ventilation Upgrades

The work consists of providing and installing a packaged ventilation unit with hot water heating, DX cooling and energy recovery on the roof of Building K. The ventilation unit will serve the first, second and third floors of Building K. The hot water heating coil will be served by a steam convertor and dedicated glycol hydronic system. The ventilation unit will connect to grilles installed under a separate project using vertical duct risers. The existing floor slabs will need to be cut to allow for the duct risers, and the openings framed with structural steel. The vertical duct risers will be boxed out on the second and third floors. As an alternate price, VRF heat recovery units will be tied into an existing system to serve the day rooms on the first, second and third floors of Building K.

The cost of the work is approximately \$ 270,900. The work to be performed under this contract shall be completed on or before *November 1, 2019*.

1. Sealed Contractor bids for the project noted above, in envelopes plainly marked "Bid for *Dorothea Dix Building K Ventilation Upgrades*" and addressed to:
Mark Faulkner, Director of Facilities
Dorothea Dix Psychiatric Center
656 State Street
Bangor, ME 04401

will be opened and read aloud at (*Dorothea Dix Psychiatric Center, CI Conference Room*) at **2:00 p.m. on May 10, 2019** . Bids submitted after the noted time will not be considered and will be returned unopened.

2. The bid shall be submitted on the Contractor Bid Form (section 00 41 13) provided in the Bid Documents. The Owner reserves the right to accept or reject any or all bids as may best serve the interest of the Owner.
3. Bid security *is not required* on this project.
The Bidder shall include a satisfactory Bid Bond (section 00 43 13) or a certified or cashier's check for 5% of the bid amount with the completed bid form submitted to the Owner.
4. Performance and Payment Bonds *are not required* on this project.
The selected Contractor shall to furnish a 100% contract Performance Bond (section 00 61 13.13) and a 100% contract Payment Bond (section 00 61 13.16) in the contract amount to cover the execution of the Work.
5. Filed Sub-bids *are not required* on this project.
6. There *are no* Pre-qualified General Contractors on this project.
The Pre-qualified General Contractors are listed below.

//

00 11 13
Notice to Contractors

7. An on-site pre-bid conference *will* be conducted for this project. The pre-bid conference is *mandatory* for General Contractors and optional for Subcontractors and suppliers. *Dorothea Dix Psychiatric Center, Main Lobby, April 25, 2019. Meet at main lobby at 11:00 am to obtain security tags. Walk-through will begin at 11:30.*

Please note: *Bidders will be required to bring with them a valid driver's license or other means of positive identification.*

8. Bid Documents - full sets only - will be available on or about *April 19, 2019* and may be purchased for \$150 from:

*Harriman
46 Harriman Drive
Auburn, ME 04210
207-784-5100*

9. Bid Documents may be examined at:

*AGC Maine
188 Whitten Road
Augusta, ME 04332
Phone 207-622-4741 Fax 207-622-1625*

*Construction Summary
734 Chestnut Street
Manchester, NH 03104
Phone 603-627-8856 Fax 603-627-4524*

Dodge Reports

*Harriman
46 Harriman Drive
Auburn, ME 04210
Phone 207-784-5100 Fax 207-782-3017*

00 21 13
Instructions to Bidders

1. Bidder Requirements

- 1.1 A bidder is a Contractor who is qualified, or has been specifically pre-qualified by the Bureau of Real Estate Management, to bid on the proposed project described in the Bid Documents.
- 1.2 Contractors and Subcontractors bidding on projects that utilize Filed Sub-bids shall follow the requirements outlined in these Bid Documents for such projects. See Section 00 22 13 for additional information.
- 1.3 Contractors and Subcontractors are not eligible to bid on the project when their access to project design documents prior to the bid period distribution of documents creates an unfair bidding advantage. Prohibited access includes consultation with the Owner or with design professionals engaged by the Owner regarding cost estimating, constructability review, or project scheduling. This prohibition to bid applies to open, competitive bidding or pre-qualified contractor bidding or Filed Sub-bidding. The Bureau may require additional information to determine if the activities of a Contractor constitute an unfair bidding advantage.
- 1.4 Each bidder is responsible for becoming thoroughly familiar with the Bid Documents prior to submitting a bid. The failure of a bidder to review evident site conditions, to attend available pre-bid conferences, or to receive, examine, or act on addenda to the Bid Documents shall not relieve that bidder from any obligation with respect to their bid or the execution of the work as a Contractor.
- 1.5 Prior to the award of the contract, General Contractor bidders or Filed Sub-bidders may be required to provide documented evidence to the Owner or the Bureau showing compliance with the provisions of this section, their business experience, financial capability, or performance on previous projects.
- 1.6 The selected General Contractor bidder will be required to provide proof of insurance before a contract can be executed.
- 1.7 Contracts developed from this bid shall not be assigned, sublet or transferred without the written consent of the Owner.
- 1.8 By submitting a bid the Contractor attests that it has not been declared ineligible to bid on State of Maine projects. The Director of the Bureau of Real Estate Management may disallow award of this contract to any Contractor if there is evidence that the Contractor or any of its Subcontractors, through their own fault, have been terminated, suspended for cause, debarred from bidding, agreed to refrain from bidding as part of a settlement, have defaulted on a contract, or had a contract completed by another party.
- 1.9 The Contractor attests that it is not presently indicted for or otherwise criminally or civilly charged by a Federal, State or local government entity with commission of any of the following offenses and has not within a three-year period preceding this bid 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 anti-trust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property.
- 1.10 The Contractor shall not make any award or permit any award (subgrant or contract) at any tier to any party which is debarred or suspended or is otherwise excluded from or ineligible for participation in Federal assistance programs or State of Maine projects.

00 21 13
Instructions to Bidders

2. Authority of Owner

- 2.1 The Owner reserves the right to accept or reject any or all bids as may best serve the interest of the Owner and the State of Maine.
- 2.2 Subject to the Owner's stated right to accept or reject any or all bids, the Contractor shall be selected on the basis of the lowest sum of an acceptable Base Bid plus any Alternate Bids the Owner elects to include. An acceptable bid is one from a responsive and responsible bidder.
- 2.3 The Owner is exempt from the payment of Federal Excise Taxes and Federal Transportation Tax on all shipments, as well as Maine State Sales and Use Taxes on items "...physically incorporated in real property ...". The bidder shall not include these taxes in their bid. See Section 00 72 13 for additional information.

3. Submitting Bids and Bid Requirements

- 3.1 Each bid shall be submitted on the forms provided in the Bid Documents.
- 3.2 Each bid shall be valid for a period of thirty calendar days following the Project bid opening date and time.
- 3.3 A bid that contains an escalation clause is considered invalid.
- 3.4 Bidders shall include a Bid Bond or other approved bid security with the bid form submitted to the Owner when the bid form indicates such bid security is required. The bond value shall be 5% of the bid amount. The form of bond is shown in section 00 43 13.
- 3.5 Bidders shall include the cost of Performance and Payment Bonds in the bid amount if the bid amount will result in a construction contract value over \$125,000, inclusive of alternate bids that may be awarded in the contract. Pursuant to 14 M.R.S.A., Section 871, Public Works Contractors' Surety Bond Law of 1971, subsection 3, the selected Contractor is required to provide these bonds before a contract can be executed. The form of bonds are shown in section 00 61 13.13 and 00 61 13.16.
- 3.6 Bidders may modify bids in writing prior to the bid closing time. Such written amendments shall not disclose the amount of the initial bid. If so disclosed, the entire bid is considered invalid.
- 3.7 Bidders shall acknowledge on the bid form all Addenda issued in a timely manner. The Architect shall not issue Addenda affecting bidders less than 72 hours prior to the bid closing time. Addenda shall be issued to all companies who are registered holders of Bid Documents.
- 3.8 A bid may be withdrawn without penalty if a written request by the bidder is presented to the Owner prior to the bid closing time. Such written withdrawal requests are subject to verification as required by the Bureau. After the bid closing time, such written withdrawal requests may be allowed in consideration of the bid bond or, without utilizing a bid bond, if the Contractor provides documented evidence to the satisfaction of the Bureau that factual errors had been made on the bid form.
- 3.9 In the event State of Maine Offices unexpectedly close on the published date of a public bid opening in the location of that bid opening, prior to the time of the scheduled deadline, the new deadline for the public bid opening will be the following business day at the originally scheduled hour of the day, at the original location. Official closings are posted on the State of Maine government website.
- 3.10 Projects which require a State of Maine wage determination will include that schedule as part of the Bid Documents. See section 00 73 46, if such rates are required.
- 3.11 Projects which require compliance with the Davis-Bacon Act are subject to the regulations contained the Code for Federal Regulations and the federal wage determination which is made a part of the Bid Documents. See section 00 73 46, if such rates are required.

**00 41 13
Contractor Bid Form**

Dorothea Dix Building K Ventilation Upgrades

To: *Mark Faulkner, Director of Facilities*
Dorothea Dix Psychiatric Center
656 State Street
Bangor, ME 04401

The undersigned, or *Bidder*, having carefully examined the form of contract, general conditions, specifications and drawings dated 19 April 2019, prepared by Harriman for Dorothea Dix Building K Ventilation Upgrades, as well as the premises and conditions relating to the work, proposes to furnish all labor, equipment and materials necessary for and reasonably incidental to the construction and completion of this project for the **Base Bid** amount of:

\$ _____ .00

1. Allowances *are not included* on this project.
No Allowances

\$

2. Alternate Bids *are included* on this project.

Alternate Bids are as shown below

Any dollar amount line below that is left blank by the Bidder shall be taken as a bid of **\$0.00**.

1	<i>Extend VRF System for K-1, K-2 & K-3 Day Rooms</i>	\$ _____ <u>.00</u>
2	<i>"not used"</i>	\$ _____ <u>.00</u>
3	<i>"not used"</i>	\$ _____ <u>.00</u>
4	<i>"not used"</i>	\$ _____ <u>.00</u>
5	<i>"not used"</i>	\$ _____ <u>.00</u>

**00 41 13
Contractor Bid Form**

3. The Bidder acknowledges receipt of the following addenda to the specifications and drawings:

Addendum No. _____ Dated: _____

Addendum No. _____ Dated: _____

Addendum No. _____ Dated: _____

Addendum No. _____ Dated: _____

Addendum No. _____ Dated: _____

4. Bid security *is not required* on this project.
If noted above as required, the Bidder shall include a satisfactory Bid Bond (section 00 43 13) or a certified or cashier's check for 5% of the bid amount with this completed bid form submitted to the Owner.
5. Filed Sub-bids *are not required* on this project.

**00 41 13
Contractor Bid Form**

Dorothea Dix Building K Ventilation Upgrades

6. The Bidder agrees, if this bid is accepted by the Owner, to sign the designated Owner-Contractor contract and deliver it, with any and all bonds and affidavits of insurance specified in the Bid Documents, within twelve calendar days after the date of notification of such acceptance, except if the twelfth day falls on a State of Maine government holiday or other closure day, or a Saturday, or a Sunday, in which case the aforementioned documents must be received before 12:00 noon on the first available business day following the holiday, other closure day, Saturday, or Sunday.

As a guarantee thereof, the Bidder submits, together with this bid, a bid bond or other acceptable instrument as and if required by the Bid Documents.

7. This bid is hereby submitted by:

Signature: _____

Printed name and title: _____

Company name: _____

Mailing address: _____

City, state, zip code: _____

Phone number: _____

Email address: _____

State of incorporation,
if a corporation: _____

List of all partners,
if a partnership: _____

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State of Maine
CONSTRUCTION CONTRACT

Large Construction Project

(Contract value \$50,000 or greater. Contract includes Project Manual, Specifications and Drawings)

Agreement entered into by and between the State of Maine through the **insert contracting entity name** hereinafter called the **Owner** and **insert Contractor company name** hereinafter called the **Contractor**.

BREM Project No.: **insert number assigned by BREM (not the PIP number)**

Other Project No.: _____

For the following Project: **title of project shown on documents** at **facility or campus name, municipality**, Maine.

The Specifications and the Drawings have been prepared by **firm name**, acting as Professional-of-Record and named in the documents as the Consultant Architect or Engineer.

The **Owner** and **Contractor** agree as follows:

ARTICLE 1 COMPENSATION AND PAYMENTS

1.1 The Owner shall pay the Contractor to furnish all labor, equipment, materials and incidentals necessary for the construction of the Work described in the Specifications and shown on the Drawings the Contract Amount as shown below.

Base Bid	<u>\$0.00</u>
<u><i>Alternate Bid number and name</i></u>	<u>\$0.00</u>
<u><i>Alternate Bid number and name</i></u>	<u>\$0.00</u>
<u><i>Alternate Bid number and name</i></u>	<u>\$0.00</u>
<u><i>Alternate Bid number and name</i></u>	<u>\$0.00</u>
<u><i>Alternate Bid number and name</i></u>	<u>\$0.00</u>
Total Contract Amount	<u>\$0.00</u>

1.2 The Contractor's requisition shall contain sufficient detail and supporting information for the Owner to evaluate and support the payment requested.

1.2.1 Payments are due and payable twenty-five working days from the date of receipt of a Contractor requisition which is approved by the Owner.

1.2.2 Provisions for late payments will be governed by 5 M.R.S. Chapter 144, *Payment of Invoices Received from Business Concerns*, and interest shall be calculated at 1% per month.

ARTICLE 2 TIME OF COMPLETION

2.1 The Work of this Contract shall be completed on or before the Final Completion date of **31 December 2020**.

The following abbreviated definitions are for reference only, see Section 00 71 00 *Definitions* for actual definitions.

Substantial Completion: date of first beneficial use by the Owner.

Final Completion: the Contractor's final completion deadline.

Contract Expiration: the Owner's deadline for management of contract accounts.

ARTICLE 3 INELIGIBLE BIDDER

3.1 By signing this contract the Contractor attests that it has not been declared ineligible to bid on State of Maine projects. The Bureau of Real Estate Management may disallow award of this contract to any Contractor if there is evidence that the Contractor or any of its Subcontractors, through their own fault, have been terminated, suspended for cause, debarred from bidding, agreed to refrain from bidding as part of a settlement, have defaulted on a contract, or had a contract completed by another party.

3.2 By signing this contract the Contractor attests that it is not presently indicted for or otherwise criminally or civilly charged by a Federal, State or local government entity with commission of any of the following offenses and has not within a three-year period preceding this bid 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 anti-trust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property.

3.3 The Contractor shall not make any award or permit any award (subgrant or contract) at any tier to any party which is debarred or suspended or is otherwise excluded from or ineligible for participation in Federal assistance programs or State of Maine projects.

ARTICLE 4 CONTRACTOR'S RESPONSIBILITIES

4.1 On this project, the Contractor *shall* furnish the Owner the appropriate contract bonds in the amount of 100% of the Contract Sum. Contract bonds are mandated if the Contract Sum exceeds \$125,000, or if bonds are specifically required by the Contract Documents.

4.2 Property Insurance for this construction contract, described in the Insurance Requirements section of the General Conditions of the contract, shall be **Non-standard project insured by Contractor.**

4.3 The Contractor shall comply with all laws, codes and regulations applicable to the Work.

4.4 The Contractor shall acquire all permits and third-party approvals applicable to the Work not specifically identified as provided by the Owner. Costs for Contractor-provided permits and third-party approvals shall be included in the Contract Sum identified in Section 1.1 above.

4.5 The Contractor shall remain an independent agent for the duration of this Contract, shall not become an employee of the State of Maine, and shall assure that no State employee will be compensated by, or otherwise benefit from, this Contract.

4.6 The Contractor shall be responsible for any design cost, construction cost, or other cost incurred on the Project to the extent caused by the negligent acts, errors or omissions of the Contractor or their Subcontractors in the performance of Work under this Contract.

ARTICLE 5 OWNER'S RESPONSIBILITIES

5.1 The Owner shall provide full information about the objectives, schedule, constraints and existing conditions of the project. The Owner has established a budget with reasonable contingencies that meets the project requirements.

5.2 By signing this contract the Owner attests that all State of Maine procurement requirements for this contract have been met, including the solicitation of competitive bids.

ARTICLE 6 INSTRUMENTS OF SERVICE

6.1 The Contractor's use of the drawings, specifications and other documents known as the Consultant's Instruments of Service is limited to the execution of the Contractor's scope of work of this project unless the Contractor receives the written consent of the Owner and Consultant for use elsewhere.

ARTICLE 7 MISCELLANEOUS PROVISIONS

7.1 This Contract shall be governed by the laws of the State of Maine.

7.2 The Owner and Contractor, respectively, bind themselves, their partners, successors, assigns and legal representatives to this Contract. Neither party to this Contract shall assign the Contract as a whole without written consent of the other party, which consent the Owner may withhold without cause.

7.3 Notwithstanding any other provision of this Agreement, if the Owner does not receive sufficient funds to fund this Agreement or funds are de-appropriated, or if the Owner does not receive legal authority from the Maine State Legislature or Maine Courts to expend funds intended for this Agreement, then the Owner is not obligated to make payment under this Agreement; provided, however, the Owner shall be obligated to pay for services satisfactorily performed prior to any such non-appropriation in accordance with the termination provisions of this agreement. The Owner shall timely notify the Consultant of any non-appropriation and the effective date of the non-appropriation.

ARTICLE 8 CONTRACT DOCUMENTS

8.1 The General Conditions of the contract, instructions to bidders, bid form, Special Provisions, the written specifications and the drawings, and any Addenda, together with this agreement, form the contract. Each element is as fully a part of the Contract as if hereto attached or herein repeated.

8.2 Specifications: **indicate date of issuance of project manual**

8.3 Drawings: **note each sheet number and title**

8.4 Addenda: **note each addenda number and date, or "none"**

BREM Project No.: _____

The Agreement is effective as of the date last executed by the parties.

OWNER

CONTRACTOR

(Signature) *(Date)*
name and title

name of contracting entity

(Signature) *(Date)*
name and title

name of contractor company

(Indicate names of the review and approval individuals appropriate to the approval authority.)

<i>select proper approval authority</i>			
Reviewed by:		Approved by:	
_____ <i>(Signature)</i>	_____ <i>(Date)</i>	_____ <i>(Signature)</i>	_____ <i>(Date)</i>
<i>insert name</i>		<i>Joseph H. Ostwald</i>	
<i>Project Manager/ Contract Administrator</i>		<i>Director, Planning, Design & Construction</i>	

00 71 00
Definitions

1. Definitions

- 1.1 *Addendum*: A document issued by the Consultant that amends the Bid Documents. Addenda shall not be issued less than seventy-two hours prior to the specified bid opening time.
- 1.2 *Allowance*: A specified dollar amount for a particular scope of work or service included in the Work that is identified in the Bid Documents and included in each Bidder's Bid. The Contractor shall document expenditures for an Allowance during the Project. Any unused balance shall be credited to the Owner. The Contractor is responsible for notifying the Owner of anticipated expenses greater than the specified amount and the Owner is responsible for those additional expenses.
- 1.3 *Alternate Bid*: The Contractor's written offer of a specified dollar amount, submitted on the Bid Form, for the performance of a particular scope of work described in the Bid Documents. The Owner determines the low bidder based on the sum of the base Bid and any combination of Alternate Bids that the Owner selects.
- 1.4 *Architect*: A Consultant acting as, or supporting, the Professional-of-Record who is responsible for the design of the Project. Equivalent to "Consultant" in State of Maine contract forms.
- 1.5 *Architectural Supplemental Instruction (ASI)*: A written instruction from the Architect for the purpose of clarification of the Contract Documents. An ASI does not alter the Contract Price or Contract Time. ASIs may be responses to RFIs and shall be issued by the Architect in a timely manner to avoid any negative impact on the Schedule of Work.
- 1.6 *Bid*: The Contractor's written offer of a specified dollar amount or amounts, submitted on a form included in the Bid Documents, for the performance of the Work. A Bid may include bonds or other requirements. A base Bid is separate and distinct from Alternate Bids, being the only cost component necessary for the award of the contract, and representing the minimum amount of Work that is essential for the functioning of the Project.
- 1.7 *Bid Bond*: The security designated in the Bid Documents, furnished by Bidders as a guaranty of good faith to enter into a contract with the Owner, should a contract be awarded to that Bidder.
- 1.8 *Bidder*: Any business entity, individual or corporation that submits a bid for the performance of the work described in the Bid Documents, acting directly or through a duly authorized representative.
- 1.9 *Bid Documents*: The drawings, procurement and contracting requirements, general requirements, and the written specifications -including all addenda, that a bidder is required to reference in the submission of a bid.
- 1.10 *Bureau*: The State of Maine Bureau of Real Estate Management (formerly known as Bureau of General Services, or BGS) in the Department of Administrative and Financial Services.
- 1.11 *Calendar days*: Consecutive days, as occurring on a calendar, taking into account each day of the week, month, year, and any religious, national or local holidays. Calendar days are used for changes in Contract Time.
- 1.12 *Certificate of Substantial Completion*: A document developed by the Consultant that describes the final status of the Work and establishes the date that the Owner may use the facility for its intended

00 71 00
Definitions

purpose. The Certificate of Substantial Completion may also include a provisional list of items - a "punch list" - remaining to be completed by the Contractor. The Certificate of Substantial Completion identifies the date from which the project warranty period commences.

- 1.13 *Certificate of Occupancy*: A document developed by a local jurisdiction such as the Code Enforcement Officer that grants permission to the Owner to occupy a building.
- 1.14 *Change Order (CO)*: A document that modifies the contract and establishes the basis of a specific adjustment to the Contract Price or the Contract Time, or both. Change Orders may address correction of omissions, errors, and document discrepancies, or additional requirements. Change Orders should include all labor, materials and incidentals required to complete the work described. A Change Order is not valid until signed by the Contractor, Owner and Consultant and approved by the Bureau.
- 1.15 *Change Order Proposal (COP) (see also Proposal)*: Contract change proposed by the Contractor regarding the contract amount, requirements, or time. The Contractor implements the work of a COP after it is accepted by all parties. Accepted COPs are incorporated into the contract by Change Order.
- 1.16 *Clerk of the Works*: The authorized representative of the Consultant on the job site. Clerk of the Works is sometimes called the Architect's representative.
- 1.17 *Construction Change Directive (CCD)*: A written order prepared by the Consultant and signed by the Owner and Consultant, directing a change in the Work prior to final agreement with the Contractor on adjustment, if any, in the Contract Price or Contract Time, or both.
- 1.18 *Contract*: A written agreement between the Owner and the successful bidder which obligates the Contractor to perform the work specified in the Contract Documents and obligates the Owner to compensate the Contractor at the mutually accepted sum, rates or prices.
- 1.19 *Contract Bonds (also known as Payment and Performance Bonds)*: The approved forms of security, furnished by the Contractor and their surety, which guarantee the faithful performance of all the terms of the contract and the payment of all bills for labor, materials and equipment by the Contractor.
- 1.20 *Contract Documents*: The drawings and written specifications (including all addenda), Standard General Conditions, and the contract (including all Change Orders subsequently incorporated in the documents).
- 1.21 *Contract Price*: The dollar amount of the construction contract, also called *Contract Sum*.
- 1.22 *Contract Time*: The designated duration of time to execute the Work of the contract, with a specific date for completion.
- 1.23 *Contractor*: Also called the "General Contractor" or "GC" the individual or entity undertaking the execution of the general contract work under the terms of the contract with the Owner, acting directly or through a duly authorized representative. The Contractor is responsible for the means, methods and materials utilized in the execution and completion of the Work.
- 1.24 *Consultant*: The Architect or Engineer acting as Professional-of-Record for the Project. The Consultant is responsible for the design of the Project.

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- 1.25 *Drawings*: The graphic and pictorial portion of the Contract Documents showing the design, location and dimensions of the Work, generally including plans, elevations, sections, details, schedules, and diagrams.
- 1.26 *Engineer*: A Consultant acting as, or supporting, the Professional-of-Record who is responsible for the design of the Project. Equivalent to “Consultant” in State of Maine contract forms.
- 1.27 *Filed Sub-bid*: The designated major Subcontractor's (or, in some cases, Contractor's) written offer of a specified dollar amount or amounts, submitted on a form included in the Bid Documents, for the performance of a particular portion of the Work. A Filed Sub-bid may include bonds or other requirements.
- 1.28 *Final Completion*: Project status establishing the date when the Work is fully completed in compliance with the Contract Documents, as certified by the Consultant. Final payment to the Contractor is due upon Final Completion of the Project.
- 1.29 *General Requirements*: The on-site overhead expense items the Contractor provides for the Project, typically including, but not limited to, building permits, construction supervision, Contract Bonds, insurance, field office, temporary utilities, rubbish removal, and site fencing. Overhead expenses of the Contractor's general operation are not included. Sometimes referred to as the Contractor's General Conditions.
- 1.30 *Owner*: The State agency which is represented by duly authorized individuals. The Owner is responsible for defining the scope of the Project and compensation to the Consultant and Contractor.
- 1.31 *Owner's Representative*: The individual or entity contracted by the Owner to be an advisor and information conduit regarding the Project.
- 1.32 *Overhead*: General and administrative expenses of the Contractor's principal and branch offices, including payroll costs and other compensation of Contractor employees, deductibles paid on any insurance policy, charges against the Contractor for delinquent payments, and costs related to the correction of defective work, and the Contractor's capital expenses, including interest on capital used for the work.
- 1.33 *Performance and Payment Bonds (also known as Contract Bonds)*: The approved forms of security, furnished by the Contractor and their surety, which guarantee the faithful performance of all the terms of the contract and the payment of all bills for labor, materials and equipment by the Contractor.
- 1.34 *Post-Bid Addendum*: Document issued by the Consultant that defines a potential Change Order prior to signing of the construction contract. The Post-Bid Addendum allows the Owner to negotiate contract changes with the Bidder submitting the lowest valid bid, only if the negotiated changes to the Bid Documents result in no change or no increase in the bid price.

A Post-Bid Addendum may also be issued after a competitive construction Bid opening to those Bidders who submitted a Bid initially, for the purpose of rebidding the Project work without re-advertising.

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- 1.35 *Project*: The construction project proposed by the Owner to be constructed according to the Contract Documents. The Project, a public improvement, may be tied logistically to other public improvements and other activities conducted by the Owner or other contractors.
- 1.36 *Proposal (see also Change Order Proposal)*: The Contractor's written offer submitted to the Owner for consideration containing a specified dollar amount or rate, for a specific scope of work, and including a schedule impact, if any. A proposal shall include all costs for overhead and profit. The Contractor implements the work of a Proposal after it is accepted by all parties. Accepted Proposals are incorporated into the contract by Change Order.
- 1.37 *Proposal Request (PR)*: An Owner's written request to the Contractor for a Change Order Proposal.
- 1.38 *Punch List*: A document that identifies the items of work remaining to be done by the Contractor at the Close Out of a Project. The Punch List is created as a result of a final inspection of the work only after the Contractor attests that all of the Work is in its complete and permanent status.
- 1.39 *Request For Information (RFI)*: A Contractor's written request to the Consultant for clarification, definition or description of the Work. RFIs shall be presented by the Contractor in a timely manner to avoid any negative impact on the Schedule of Work.
- 1.40 *Request For Proposal (RFP)*: An Owner's written request to the Contractor for a Change Order Proposal.
- 1.41 *Requisition for Payment*: The document in which the Contractor certifies that the Work described is, to the best of the Contractor's knowledge, information and belief, complete and that all previous payments have been paid by the Contractor to Subcontractors and suppliers, and that the current requested payment is now due. See *Schedule of Values*.
- 1.42 *Retainage*: The amount, calculated at five percent (5%) of the contract value or a scheduled value, that the Owner shall withhold from the Contractor until the work or portion of work is declared substantially complete or otherwise accepted by the Owner. The Owner may, if requested, reduce the amount withheld if the Owner deems it desirable and prudent to do so. (See Title 5 M.R.S.A., Section 1746.)
- 1.43 *Sample*: A physical example provided by the Contractor which illustrates materials, equipment or workmanship and establishes standards by which the Work will be judged.
- 1.44 *Schedule of the Work*: The document prepared by the Contractor and approved by the Owner that specifies the dates on which the Contractor plans to begin and complete various parts of the Work, including dates on which information and approvals are required from the Owner.
- 1.45 *Schedule of Values*: The document prepared by the Contractor and approved by the Owner before the commencement of the Work that specifies the dollar values of discrete portions of the Work equal in sum to the contract amount. The Schedule of Values is used to document progress payments of the Work in regular (usually monthly) requisitions for payment. See *Requisition for Payment*.
- 1.46 *Shop Drawings*: The drawings, diagrams, schedules and other data specially prepared for the Work by the Contractor or a Subcontractor, manufacturer, supplier or distributor to illustrate some portion of the Work.

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- 1.47 *Specifications*: The portion of the Contract Documents consisting of the written requirements of the Work for materials, equipment, systems, standards, workmanship, and performance of related services.
- 1.48 *Subcontractor*: An individual or entity undertaking the execution of any part of the Work by virtue of a written agreement with the Contractor or any other Subcontractor. Also, an individual or entity retained by the Contractor or any other Subcontractor as an independent contractor to provide the labor, materials, equipment or services necessary to complete a specific portion of the Work.
- 1.49 *Substantial Completion*: Project status indicating when the Work or a designated portion of the Work is sufficiently complete in compliance with the Contract Documents so that the Owner can occupy or utilize the Work for its intended purpose without unscheduled disruption. Substantial Completion is documented by the date of the Certificate of Substantial Completion signed by the Owner and the Contractor.
- 1.50 *Superintendent*: The representative of the Contractor on the job site, authorized by the Contractor to receive and fulfill instructions from the Consultant.
- 1.51 *Surety*: The individual or entity that is legally bound with the Contractor and Subcontractor to insure the faithful performance of the contract and for the payment of the bills for labor, materials and equipment by the Contractor and Subcontractors.
- 1.52 *Work*: The construction and services, whether completed or partially completed, including all labor, materials, equipment and services provided or to be provided by the Contractor and Subcontractors to fulfill the requirements of the Project as described in the Contract Documents.

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1. Preconstruction Conference

- 1.1 The Contractor shall, upon acceptance of a contract and prior to commencing work, schedule a preconstruction conference with the Owner and Consultant. The purpose of this conference is as follows.
 - 1.1.1 Introduce all parties who have a significant role in the Project, including:
 - Owner (State agency or other contracting entity)
 - Owner's Representative
 - Consultant (Architect or Engineer)
 - Subconsultants
 - Clerk-of-the-works
 - Contractor (GC)
 - Superintendent
 - Subcontractors
 - Other State agencies
 - Construction testing company
 - Commissioning agent
 - Special Inspections agent
 - Bureau of Real Estate Management (BREM);
 - 1.1.2 Review the responsibilities of each party;
 - 1.1.3 Review any previously-identified special provisions of the Project;
 - 1.1.4 Review the Schedule of the Work calendar submitted by the Contractor to be approved by the Owner and Consultant;
 - 1.1.5 Review the Schedule of Values form submitted by the Contractor to be approved by the Owner and Consultant;
 - 1.1.6 Establish routines for Shop Drawing approval, contract changes, requisitions, et cetera;
 - 1.1.7 discuss jobsite issues;
 - 1.1.8 Discuss Project close-out procedures;
 - 1.1.9 Provide an opportunity for clarification of Contract Documents before work begins; and
 - 1.1.10 Schedule regular meetings at appropriate intervals for the review of the progress of the Work.

2. Intent and Correlation of Contract Documents

- 2.1 The intent of the Contract Documents is to describe the complete Project. The Contract Documents consist of various components; each component complements the others. What is shown as a requirement by any one component shall be inferred as a requirement on all corresponding components.
- 2.2 The Contractor shall furnish all labor, equipment and materials, tools, transportation, insurance, services, supplies, operations and methods necessary for, and reasonably incidental to, the construction and completion of the Project. Any work that deviates from the Contract Documents which appears to be required by the exigencies of construction or by inconsistencies in the Contract Documents, will be determined by the Consultant and authorized in writing by the Consultant, Owner and the Bureau prior to execution. The Contractor shall be responsible for requesting clarifying information where the intent of the Contract Documents is uncertain.
- 2.3 The Contractor shall not utilize any apparent error or omission in the Contract Documents to the disadvantage of the Owner. The Contractor shall promptly notify the Consultant in writing of

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such errors or omissions. The Consultant shall make any corrections or clarifications necessary in such a situation to document the true intent of the Contract Documents.

3. Additional Drawings and Specifications

- 3.1 Upon the written request of the Contractor, the Owner shall provide, at no expense to the Contractor, up to five sets of printed Drawings and Specifications for the execution of the Work.
- 3.2 The Consultant shall promptly furnish to the Contractor revised Drawings and Specifications, for the area of the documents where those revisions apply, when corrections or clarifications are made by the Consultant. All such information shall be consistent with, and reasonably inferred from, the Contract Documents. The Contractor shall do no work without the proper Drawings and Specifications.

4. Ownership of Contract Documents

- 4.1 The designs represented on the Contract Documents are the property of the Consultant. The Drawings and Specifications shall not be used on other work without consent of the Consultant.

5. Permits, Laws, and Regulations

- 5.1 The Owner is responsible for obtaining any zoning approvals or other similar local project approvals necessary to complete the Work, unless otherwise specified in the Contract Documents.
- 5.2 The Owner is responsible for obtaining Maine Department of Environmental Protection, Maine Department of Transportation, or other similar state government project approvals necessary to complete the Work, unless otherwise indicated in the Contract Documents.
- 5.3 The Owner is responsible for obtaining any federal agency project approvals necessary to complete the Work, unless otherwise indicated in the Contract Documents.
- 5.4 The Owner is responsible for obtaining all easements for permanent structures or permanent changes in existing facilities.
- 5.5 The Contractor is responsible for obtaining and paying for all permits and licenses necessary for the implementation of the Work. The Contractor shall notify the Owner of any delays, variance or restrictions that may result from the issuing of permits and licenses.
- 5.6 The Contractor shall comply with all ordinances, laws, rules and regulations and make all required notices bearing on the implementation of the Work. In the event the Contractor observes disagreement between the Drawings and Specifications and any ordinances, laws, rules and regulations, the Contractor shall promptly notify the Consultant in writing. Any necessary changes shall be made as provided in the contract for changes in the work. The Contractor shall not perform any work knowing it to be contrary to such ordinances, laws, rules and regulations.
- 5.7 The Contractor shall comply with local, state and federal regulations regarding construction safety and all other aspects of the Work.

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5.8 The Contractor shall comply with the Maine Code of Fair Practices and Affirmative Action, 5 M.R.S. §784 (2).

6. Taxes

6.1 The Owner is exempt from the payment of Federal Excise Taxes on articles not for resale and from the Federal Transportation Tax on all shipments, as well as Maine State Sales and Use Taxes. Pricing in all Change Order Proposals from the Contractor and Subcontractors shall not include these taxes.

6.2 Maine statute (36 M.R.S. §1760) allows "...an exemption from sales and use tax on items which will be physically incorporated in real property of an exempt organization. This exemption only applies to lumber, hardware, doors and windows, nails, insulation and other building materials actually affixed to realty. Tools, wearing apparel, consumable supplies, machinery and equipment used by the Contractor are taxable even if purchased specifically for the exempt job."

6.3 The Contractor may contact Maine Revenue Services, 24 State House Station, Augusta, Maine 04333 for guidance on tax exempt regulations authorized by 36 M.R.S. §1760 and detailed in Rule 302 (18-125 CMR 302).

7. Labor and Wages

7.1 The Contractor shall conform to the labor laws of the State of Maine, and all other laws, ordinances, and legal requirements affecting the work in Maine.

7.2 The Consultant shall include a wage determination document prepared by the Maine Department of Labor in the Contract Documents for state-funded contracts in excess of \$50,000. The document shows the minimum wages required to be paid to each category of labor employed on the project.

7.3 On projects requiring a Maine wage determination, the Contractor shall submit monthly payroll records to the Owner ("the contracting agency") showing the name and occupation of all workers and all independent contractors employed on the project. The monthly submission must also include the Contractor's company name, the title of the project, hours worked, hourly rate or other method of remuneration, and the actual wages or other compensation paid to each person.

7.4 The Contractor shall not reveal, in the payroll records submitted to the Owner, personal information regarding workers and independent contractors, other than the information described above. Such information shall not include Social Security number, employee identification number, or employee address or phone number, for example.

7.5 The Contractor shall conform to Maine statute (39-A M.R.S. §105-A (6)) by providing to the Workers' Compensation Board a list of all subcontractors and independent contractors on the job site and a record of the entity to whom that subcontractor or independent contractor is directly contracted and by whom that subcontractor or independent contractor is insured for workers' compensation purposes.

7.6 The Contractor shall enforce strict discipline and good order among their employees at all times, and shall not employ any person unfit or unskilled to do the work assigned to them.

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- 7.7 The Contractor shall promptly pay all employees when their compensation is due, shall promptly pay all others who have billed and are due for materials, supplies and services used in the Work, and shall promptly pay all others who have billed and are due for insurance, workers compensation coverage, federal and state unemployment compensation, and Social Security charges pertaining to this Project. Before final payments are made, the Contractor shall furnish to the Owner affidavits that all such payments described above have been made.
- 7.8 The Contractor may contact the Maine Department of Labor, 54 State House Station, Augusta, Maine 04333 for guidance on labor issues.
- 7.9 The Contractor may contact the Maine Workers' Compensation Board, 27 State House Station, Augusta, Maine 04333 for guidance on workers' compensation issues.

8. Indemnification

- 8.1 The Contractor shall indemnify and hold harmless the Owner and its officers and employees from and against any and all damages, liabilities, and costs, including reasonable attorney's fees, and defense costs, for any and all injuries to persons or property, including claims for violation of intellectual property rights, to the extent caused by the negligent acts or omissions of the Contractor, its employees, agents, officers or subcontractors in the performance of work under this Agreement. The Contractor shall not be liable for claims to the extent caused by the negligent acts or omissions of the Owner or for actions taken in reasonable reliance on written instructions of the Owner.
- 8.2 The Contractor shall notify the Owner promptly of all claims arising out of the performance of work under this Agreement by the Contractor, its employees or agents, officers or subcontractors.
- 8.3 This indemnity provision shall survive the termination of the Agreement, completion of the project or the expiration of the term of the Agreement.

9. Insurance Requirements

- 9.1 The Contractor shall provide, with each original of the signed Contract, an insurance certificate or certificates acceptable to the Owner and BREM. The Contractor shall submit insurance certificates to the Owner and BREM at the commencement of this Contract and at policy renewal or revision dates. The certificates shall identify the project name and BREM project number, and shall name the Owner as certificate holder and as additional insured for general liability and automobile liability coverages. The submitted forms shall contain a provision that coverage afforded under the insurance policies will not be canceled or materially changed unless at least ten days prior written notice by registered letter has been given to the Owner and BREM.
- 9.2 The Owner does not warrant or represent that the insurance required herein constitutes an insurance portfolio which adequately addresses all risks faced by the Contractor or its Subcontractors. The Contractor is responsible for the existence, extent and adequacy of insurance prior to commencement of work. The Contractor shall not allow any Subcontractor to commence work until all similar insurance required of the Subcontractor has been confirmed by the Contractor.

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- 9.3 The Contractor shall procure and maintain primary insurance for the duration of the Project and, if written on a Claims-Made basis, shall also procure and maintain Extended Reporting Period (ERP) insurance for the period of time that any claims could be brought. The Contractor shall ensure that all Subcontractors they engage or employ will procure and maintain similar insurance in form and amount acceptable to the Owner and BREM. At a minimum, the insurance shall be of the types and limits set forth herein protecting the Contractor from claims which may result from the Contractor's execution of the Work, whether such execution be by the Contractor or by those employed by the Contractor or by those for whose acts they may be liable. All required insurance coverages shall be placed with carriers authorized to conduct business in the State of Maine by the Maine Bureau of Insurance.
- 9.3.1 The Contractor shall have Workers' Compensation insurance for all employees on the Project site in accordance with the requirements of the Workers' Compensation law of the State of Maine. Minimum acceptable limits for Employer's Liability are:
- Bodily Injury by Accident.....\$500,000
 - Bodily Injury by Disease.....\$500,000 Each Employee
 - Bodily Injury by Disease.....\$500,000 Policy Limit
- 9.3.2 The Contractor shall have Commercial General Liability insurance providing coverage for bodily injury and property damage liability for all hazards of the Project including premise and operations, products and completed operations, contractual, and personal injury liabilities. The policy shall include collapse and underground coverage as well as explosion coverage if explosion hazards exist. Aggregate limits shall apply on a location or project basis. Minimum acceptable limits are:
- General aggregate limit.....\$2,000,000
 - Products and completed operations aggregate\$1,000,000
 - Each occurrence limit.....\$1,000,000
 - Personal injury aggregate.....\$1,000,000
- 9.3.3 The Contractor shall have Automobile Liability insurance against claims for bodily injury, death or property damage resulting from the maintenance, ownership or use of all owned, non-owned and hired automobiles, trucks and trailers. Minimum acceptable limit is:
- Any one accident or loss\$500,000
- 9.3.4 The Contractor shall have Owner's Protective Liability insurance for contract values \$50,000 and above, naming the Owner as the Named Insured. Minimum acceptable limits are:
- General aggregate limit.....\$2,000,000
 - Each occurrence limit.....\$1,000,000
- 9.4 The Owner has determined the appropriate coverage for this particular project, verified the coverage with the State of Maine Risk Management Division, and selected the proper option on the contract form. Property Insurance for this construction contract shall one of the options described below.
- 9.4.1 New construction insured by the Contractor –
The Contractor shall procure and maintain Builder's Risk insurance naming the Owner, Contractor and any Subcontractors as insureds as their interest may appear. Covered cause of loss form shall be all Risks of Direct Physical Loss, endorsed to include flood, earthquake, transit and sprinkler leakage where sprinkler coverage is applicable. Unless specifically authorized in writing by the Owner, the limit of insurance shall not be less than the initial contract amount and

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coverage shall apply during the entire contract period until the Certificate of Substantial Completion is accepted by the Owner.

- 9.4.2 Renovations and additions to existing State-owned buildings insured by the State of Maine Risk Management Division –
Builder's Risk insurance will be provided by the State of Maine in accordance with the terms and conditions of the State's property policy. The Owner shall notify Maine Risk Management Division concerning the project, including the nature and value of the work, planned start and completion date, and the name of the General Contractor. Said insurance coverage shall cover the interests of the Contractor and Subcontractor, as their interests may appear. Exclusions common to commercial property policies may be applicable. A Builder's Risk certificate of insurance will be furnished to the Contractor upon request.

The \$500 per occurrence deductible is the responsibility of the Contractor. Should the Contractor or Subcontractor desire coverage in excess of that maintained by the State, it must be acquired by the Contractor and at Contractor expense.

- 9.4.3 Renovations and additions to existing buildings not insured by the State of Maine Risk Management Division –
The Contractor shall procure and maintain Builder's Risk insurance naming the Owner, Contractor and all Subcontractors as insureds as their interests may appear. The covered cause of loss form shall be Risks of Direct Physical Loss, endorsed to include flood, earthquake, testing and ensuing loss and shall include coverage for materials in transit and materials stored off site. Coverage shall be on a replacement cost and a completed value basis. Unless specifically authorized by the Owner, the limit of insurance shall not be less than the contract amount and coverage shall apply during the entire contract period until the Certificate of Substantial Completion is accepted by the Owner.

10. Contract Bonds

- 10.1 When noted as required in the Bid Documents, the Contractor shall provide to the Owner a Performance Bond and a Payment Bond, or "contract bonds", upon execution of the contract. Each bond value shall be for the full amount of the contract and issued by a surety company authorized to do business in the State of Maine as approved by the Owner. The bonds shall be executed on the forms furnished in the Bid Documents. The bonds shall allow for any subsequent additions or deductions of the contract.
- 10.2 The contract bonds shall continue in effect for one year after final acceptance of the contract to protect the Owner's interest in connection with the one year guarantee of workmanship and materials and to assure settlement of claims for the payment of all bills for labor, materials and equipment by the Contractor.

11. Patents and Royalties

- 11.1 The Contractor shall, for all time, secure for the Owner the free and undisputed right to the use of any patented articles or methods used in the Work. The expense of defending any suits for infringement or alleged infringement of such patents shall be borne by the Contractor. Awards made regarding patent suits shall be paid by the Contractor. The Contractor shall hold the Owner

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harmless regarding patent suits that may arise due to installations made by the Contractor, and to any awards made as a result of such suits.

- 11.2 Any royalty payments related to the work done by the Contractor for the Project shall be borne by the Contractor. The Contractor shall hold the Owner harmless regarding any royalty payments that may arise due to installations made by the Contractor.

12. Surveys, Layout of Work

- 12.1 The Owner shall furnish all property surveys unless otherwise specified.
- 12.2 The Contractor is responsible for correctly staking out the Work on the site. The Contractor shall employ a competent surveyor to position all construction on the site. The surveyor shall run the axis lines, establish correct datum points and check each line and point on the site to insure their accuracy. All such lines and points shall be carefully preserved throughout the construction.
- 12.3 The Contractor shall lay out all work from dimensions given on the Drawings. The Contractor shall take measurements and verify dimensions of any existing work that affects the Work or to which the Work is to be fitted. The Contractor is solely responsible for the accuracy of all measurements. The Contractor shall verify all grades, lines, levels, elevations and dimensions shown on the Drawings and report any errors or inconsistencies to the Consultant prior to commencing work.

13. Record of Documents

- 13.1 The Contractor shall maintain one complete set of Contract Documents on the jobsite, in good order and current status, for access by the Owner and Consultant.
- 13.2 The Contractor shall maintain, continuously updated, complete records of Requests for Information, Architectural Supplemental Instructions (or equivalent), Information Bulletins, supplemental sketches, Change Order Proposals, Change Orders, Shop Drawings, testing reports, et cetera, for access by the Owner and Consultant.

14. Allowances

- 14.1 The Contract Price shall include all allowances described in the Contract Documents. The Contractor shall include all overhead and profit necessary to implement each allowance in their Contract Price.
- 14.2 The Contractor shall not be required to employ parties for allowance work against whom the Contractor has a reasonable objection. In such a case, the Contractor shall notify the Owner in writing of their position and shall propose an alternative party to complete the work of the allowance.

15. Shop Drawings

- 15.1 The Contractor shall administer Shop Drawings prepared by the Contractor, Subcontractors, suppliers or others to conform to the approved Schedule of the Work. The Contractor shall verify all field measurements, check and authorize all Shop Drawings and schedules required by the

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Work. The Contractor is the responsible party and contact for the Contractor's work as well as that of Subcontractors, suppliers or others who provide Shop Drawings.

- 15.2 The Consultant shall review and acknowledge Shop Drawings, with reasonable promptness, for general conformity with the design concept of the project and compliance with the information provided in the Contract Documents.
- 15.3 The Contractor shall provide monthly updated logs containing: requests for information, information bulletins, supplemental instructions, supplemental sketches, change order proposals, change orders, submittals, testing and deficiencies.
- 15.4 The Contractor shall make any corrections required by the Consultant, and shall submit a quantity of corrected copies as may be needed. The acceptance of Shop Drawings or schedules by the Consultant shall not relieve the Contractor from responsibility for deviations from Drawings and Specifications, unless the Contractor has called such deviations to the attention of the Consultant at the time of submission and secured the Consultant's written approval. The acceptance of Shop Drawings or schedules by the Consultant does not relieve the Contractor from responsibility for errors in Shop Drawings or schedules.

16. Samples

- 16.1 The Contractor shall furnish for approval, with reasonable promptness, all samples as directed by the Consultant. The Consultant shall review and approve such samples, with reasonable promptness, for general conformity with the design concept of the project and compliance with the information provided in the Contract Documents. The subsequent work shall be in accord with the approved samples.

17. Substitutions

- 17.1 The Contractor shall furnish items and materials described in the Contract Documents. If the item or material specified describes a proprietary product, or uses the name of a manufacturer, the term "or approved equal" shall be implied, if it is not included in the text. The specific item or material specified establishes a minimum standard for the general design, level of quality, type, function, durability, efficiency, reliability, compatibility, warranty coverage, installation factors and required maintenance. The Drawing or written Specification shall not be construed to exclude other manufacturers products of comparable design, quality, and efficiency.
- 17.2 The Contractor may submit detailed information about a proposed substitution to the Consultant for consideration. Particular models of items and particular materials which the Contractor asserts to be equal to the items and materials identified in the Contract Documents shall be allowed only with written approval by the Consultant. The request for substitution shall include a cost comparison and a reason or reasons for the substitution.
- 17.3 The Consultant may request additional information about the proposed substitution. The approval or rejection of a proposed substitution may be based on timeliness of the request, source of the information, the considerations of minimum standards described above, or other considerations. The Consultant should briefly state the rationale for the decision. The decision shall be considered final.

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17.4 The duration of a substitution review process can not be the basis for a claim for delay in the Schedule of the Work.

18. Assignment of Contract

18.1 The Contractor shall not assign or sublet the contract as a whole without the written consent of the Owner. The Contractor shall not assign any money due to the Contractor without the written consent of the Owner.

19. Separate Contracts

19.1 The Owner reserves the right to create other contracts in connection with this Project using similar General Conditions. The Contractor shall allow the Owner's other contractors reasonable opportunity for the delivery and storage of materials and the execution of their work. The Contractor shall coordinate and properly connect the Work of all contractors.

19.2 The Contractor shall promptly report to the Consultant and Owner any apparent deficiencies in work of the Owner's other contractors that impacts the proper execution or results of the Contractor. The Contractor's failure to observe or report any deficiencies constitutes an acceptance of the Owner's other contractors work as suitable for the interface of the Contractor's work, except for latent deficiencies in the Owner's other contractors work.

19.3 Similarly, the Contractor shall promptly report to the Consultant and Owner any apparent deficiencies in their own work that would impact the proper execution or results of the Owner's other contractors.

19.4 The Contractor shall report to the Consultant and Owner any conflicts or claims for damages with the Owner's other contractors and settle such conflicts or claims for damages by mutual agreement or arbitration, if necessary, at no expense to the Owner.

19.5 In the event the Owner's other contractors sue the Owner regarding any damage alleged to have been caused by the Contractor, the Owner shall notify the Contractor, who shall defend such proceedings at the Contractor's expense. The Contractor shall pay or satisfy any judgment that may arise against the Owner, and pay all other costs incurred.

20. Subcontracts

20.1 The Contractor shall not subcontract any part of this contract without the written permission of the Owner.

20.2 The Contractor shall submit a complete list of named Subcontractors and material suppliers to the Consultant and Owner for approval by the Owner prior to commencing work. The Subcontractors named shall be reputable companies of recognized standing with a record of satisfactory work.

20.3 The Contractor shall not employ any Subcontractor or use any material until they have been approved, or where there is reason to believe the resulting work will not comply with the Contract Documents.

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- 20.4 The Contractor, not the Owner, is as fully responsible for the acts and omissions of Subcontractors and of persons employed by them, as the Contractor is for the acts and omissions of persons directly or indirectly employed by the Contractor.
- 20.5 Neither the Contract Documents nor any Contractor-Subcontractor contract shall indicate, infer or create any direct contractual relationship between any Subcontractor and the Owner.
21. Contractor-Subcontractor Relationship
- 21.1 The Contractor shall be bound to the Subcontractor by all the obligations in the Contract Documents that bind the Contractor to the Owner.
- 21.2 The Contractor shall pay the Subcontractor, in proportion to the dollar value of the work completed and requisitioned by the Subcontractor, the approved dollar amount allowed to the Contractor no more than seven days after receipt of payment from the Owner.
- 21.3 The Contractor shall pay the Subcontractor accordingly if the Contract Documents or the subcontract provide for earlier or larger payments than described in the provision above.
- 21.4 The Contractor shall pay the Subcontractor for completed and requisitioned subcontract work, less retainage, no more than seven days after receipt of payment from the Owner for the Contractor's approved Requisition for Payment, even if the Consultant fails to certify a portion of the Requisition for Payment for a cause not the fault of the Subcontractor.
- 21.5 The Contractor shall not make a claim for liquidated damages or penalty for delay in any amount in excess of amounts that are specified by the subcontract.
- 21.6 The Contractor shall not make a claim for services rendered or materials furnished by the Subcontractor unless written notice is given by the Contractor to the Subcontractor within ten calendar days of the day in which the claim originated.
- 21.7 The Contractor shall give the Subcontractor an opportunity to present and to submit evidence in any progress conference or disputes involving subcontract work.
- 21.8 The Contractor shall pay the Subcontractor a just share of any fire insurance payment received by the Contractor.
- 21.9 The Subcontractor shall be bound to the Contractor by the terms of the Contract Documents and assumes toward the Contractor all the obligations and responsibilities that the Contractor, by those documents, assumes toward the Owner.
- 21.10 The Subcontractor shall submit applications for payment to the Contractor in such reasonable time as to enable the Contractor to apply for payment as specified.
- 21.11 The Subcontractor shall make any claims for extra cost, extensions of time or damages, to the Contractor in the manner provided in these General Conditions for like claims by the Contractor to the Owner, except that the time for the Subcontractor to make claims for extra cost is seven calendar days after the receipt of Consultant's instructions.

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22. Supervision of the Work

- 22.1 During all stages of the Work the Contractor shall have a competent superintendent, with any necessary assistant superintendents, overseeing the project. The superintendent shall not be reassigned without the consent of the Owner unless a superintendent ceases to be employed by the Contractor due to unsatisfactory performance.
- 22.2 The superintendent represents the Contractor on the jobsite. Directives given by the Consultant or Owner to the superintendent shall be as binding as if given directly to the Contractor's main office. All important directives shall be confirmed in writing to the Contractor. The Consultant and Owner are not responsible for the acts or omissions of the superintendent or assistant superintendents.
- 22.3 The Contractor shall provide supervision of the Work equal to the industry's highest standard of care. The superintendent shall carefully study and compare all Contract Documents and promptly report any error, inconsistency or omission discovered to the Consultant. The Contractor may not necessarily be held liable for damages resulting directly from any error, inconsistency or omission in the Contract Documents or other instructions by the Consultant that was not revealed by the superintendent in a timely way.

23. Observation of the Work

- 23.1 The Contractor shall allow the Owner, the Consultant and the Bureau continuous access to the site for the purpose of observation of the progress of the work. All necessary safeguards and accommodations for such observations shall be provided by the Contractor.
- 23.2 The Contractor shall coordinate all required testing, approval or demonstration of the Work. The Contractor shall give sufficient notice to the appropriate parties of readiness for testing, inspection or examination.
- 23.3 The Contractor shall schedule inspections and obtain all required certificates of inspection for inspections by a party other than the Consultant.
- 23.4 The Consultant shall make all scheduled observations promptly, prior to the work being concealed or buried by the Contractor. If approval of the Work is required of the Consultant, the Contractor shall notify the Consultant of the construction schedule in this regard. Work concealed or buried prior to the Consultant's approval may need to be uncovered at the Contractor's expense.
- 23.5 The Consultant may order reexamination of questioned work, and, if so ordered, the work must be uncovered by the Contractor. If the work is found to conform to the Contract Documents, the Owner shall pay the expense of the reexamination and remedial work. If the work is found to not conform to the Contract Documents, the Contractor shall pay the expense, unless the defect in the work was caused by the Owner's Contractor, whose responsibility the reexamination expense becomes.
- 23.6 The Bureau shall periodically observe the Work during the course of construction and make recommendations to the Contractor or Consultant as necessary. Such recommendations shall be considered and implemented through the usual means for changes to the Work.

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24. Consultant's Status

- 24.1 The Consultant represents the Owner during the construction period, and observes the work in progress on behalf of the Owner. The Consultant has authority to act on behalf of the Owner only to the extent expressly provided by the Contract Documents or otherwise demonstrated to the Contractor. The Consultant has authority to stop the work whenever such an action is necessary, in the Consultant's reasonable opinion, to ensure the proper execution of the contract.
- 24.2 The Consultant is the interpreter of the conditions of the contract and the judge of its performance. The Consultant shall favor neither the Owner nor the Contractor, but shall use the Consultant's powers under the contract to enforce faithful performance by both parties.
- 24.3 In the event of the termination of the Consultant's employment on the project prior to completion of the work, the Owner shall appoint a capable and reputable replacement. The status of the new Consultant relative to this contract shall be that of the former Consultant.

25. Management of the Premises

- 25.1 The Contractor shall place equipment and materials, and conduct activities on the premises in a manner that does not unreasonably hinder site circulation, environmental stability, or any long term effect. Likewise, the Consultant's directions shall not cause the use of premises to be impeded for the Contractor or Owner.
- 25.2 The Contractor shall not use the premises for any purpose other than that which is directly related to the scope of work. The Owner shall not use the premises for any purpose incompatible with the proposed work simultaneous to the work of the Contractor.
- 25.3 The Contractor shall enforce the Consultant's instructions regarding information posted on the premises such as signage and advertisements, as well as activities conducted on the premises such as fires, and smoking.
- 25.4 The Owner may occupy any part of the Project that is completed with the written consent of the Contractor, and without prejudice to any of the rights of the Owner or Contractor. Such use or occupancy shall not, in and of itself, be construed as a final acceptance of any work or materials.

26. Safety and Security of the Premises

- 26.1 The Contractor shall designate, and make known to the Consultant and the Owner, a safety officer whose duty is the prevention of accidents on the site.
- 26.2 The Contractor shall continuously maintain security on the premises and protect from unreasonable occasion of injury all people authorized to be on the job site. The Contractor shall also effectively protect the property and adjacent properties from damage or loss.
- 26.3 The Contractor shall take all necessary precautions to ensure the safety of workers and others on and adjacent to the site, abiding by applicable local, state and federal safety regulations. The Contractor shall erect and continuously maintain safeguards for the protection of workers and others, and shall post signs and other warnings regarding hazards associated with the construction process, such as protruding fasteners, moving equipment, trenches and holes, scaffolding, window, door or stair openings, and falling materials.

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- 26.4 The Contractor shall restore the premises to conditions that existed prior to the start of the project at areas not intended to be altered according to the Contract Documents.
- 26.5 The Contractor shall protect existing utilities and exercise care working in the vicinity of utilities shown in the Drawings and Specifications or otherwise located by the Contractor.
- 26.6 The Contractor shall protect from damage existing trees and other significant plantings and landscape features of the site which will remain a permanent part of the site. If necessary or indicated in the Contract Documents, tree trunks shall be boxed and barriers erected to prevent damage to tree branches or roots.
- 26.7 The Contractor shall repair or replace damage to the Work caused by the Contractor's or Subcontractor's forces, including that which is reasonably protected, at the expense of the responsible party.
- 26.8 The Contractor shall not load, or allow to be loaded, any part of the Project with a force which imperils personal or structural safety. The Consultant may consult with the Contractor on such means and methods of construction, however, the ultimate responsibility lies with the Contractor.
- 26.9 The Contractor shall not jeopardize any work in place with subsequent construction activities such as blasting, drilling, excavating, cutting, patching or altering work. The Consultant must approve altering any structural components of the project. The Contractor shall supervise all construction activities carried out by others on site to ensure that the work is neatly done and in a manner that will not endanger the structure or the component parts.
- 26.10 The Contractor may act with their sole discretion in emergency situations that potentially effect health, life or serious damage to the premises or adjacent properties, to prevent such potential loss or injury. The Contractor may negotiate with the Owner for compensation for expenses due to such emergency work.
- 26.11 The Contractor and Subcontractors shall have no responsibility for the identification, discovery, presence, handling, removal or disposal of, or exposure of persons to, hazardous materials in any form at the project site. The Contractor shall avoid disruption of any hazardous materials or toxic substances at the project site and promptly notify the Owner in writing on the occasion of such a discovery.
- 26.12 The Contractor shall keep the premises free of any unsafe accumulation of waste materials caused by the work. The Contractor shall regularly keep the spaces "broom clean". See the Close-out of the Work provisions of this section regarding cleaning at the completion of the project.
27. Changes in the Work
- 27.1 The Contractor shall not proceed with extra work without an approved Change Order or Construction Change Directive. A Change Order which has been properly signed by all parties shall become a part of the contract.
- 27.2 A Change Order is the usual document for directing changes in the Work. In certain circumstances, however, the Owner may utilize a Construction Change Directive to direct the

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Contractor to perform changes in the Work that are generally consistent with the scope of the project. The Owner shall use a Construction Change Directive only when the normal process for approving changes to the Work has failed to the detriment of the Project, or when agreement on the terms of a Change Order cannot be met, or when an urgent situation requires, in the Owner's judgment, prompt action by the Contractor.

- 27.3 The Consultant shall prepare the Construction Change Directive representing a complete scope of work, with proposed Contract Price and Contract Time revisions, if any, clearly stated.
- 27.4 The Contractor shall promptly carry out a Construction Change Directive which has been signed by the Owner and the Consultant. Work thus completed by the Contractor constitutes the basis for a Change Order. Changes in the Contract Price and Contract Time shall be as defined in the Construction Change Directive unless subsequently negotiated with some other terms.
- 27.5 The method of determining the dollar value of extra work shall be by:
- .1 an estimate of the Contractor accepted by Owner as a lump sum, or
 - .2 unit prices named in the contract or subsequently agreed upon, or
 - .3 cost plus a designated percentage, or
 - .4 cost plus a fixed fee.
- 27.6 The Contractor shall determine the dollar value of the extra work for both the lump sum and cost plus designated percentage methods so as not to exceed the following rates. The rates include all overhead and profit expenses.
- .1 Contractor - for any work performed by the Contractor's own forces, up to 20% of the cost;
 - .2 Subcontractor - for work performed by Subcontractor's own forces, up to 20% of the cost;
 - .3 Contractor - for work performed by Contractor's Subcontractor, up to 10% of the amount due the Subcontractor.
- 27.7 The Contractor shall keep and provide records as needed or directed for the cost plus designated percentage method. The Consultant shall review and certify the appropriate amount which includes the Contractor's overhead and profit. The Owner shall make payments based on the Consultant's certificate.
- 27.8 Cost reflected in Change Orders shall be limited to the following: cost of materials, cost of delivery, cost of labor (including Social Security, pension, Workers' Compensation insurance, and unemployment insurance), and cost of rental of power tools and equipment. Labor cost may include a pro-ratio share of a foreman's time only in the case of an extension of contract time granted due to the Change Order.
- 27.9 Overhead reflected in Change Orders shall be limited to the following: bond premium, supervision, wages of clerks, time keepers, and watchmen, small tools, incidental expenses, general office expenses, and all other overhead expenses directly related to the Change Order.
- 27.10 The Contractor shall provide credit to the Owner for labor, materials, equipment and other costs but not overhead and profit expenses for those Change Order items that result in a net value of credit to the contract.
- 27.11 The Owner may change the scope of work of the Project without invalidating the contract. The Owner shall notify the Contractor of a change of the scope of work for the Owner's Contractors,

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which may affect the work of this Contractor, without invalidating the contract. Change Orders for extension of the time caused by such changes shall be developed at the time of directing the change in scope of work.

- 27.12 The Consultant may order minor changes in the Work, not involving extra cost, which is consistent with the intent of the design or project.
- 27.13 The Contractor shall immediately give written notification to the Consultant of latent conditions discovered at the site which materially differ from those represented in the Drawings or Specifications, and which may eventually result in a change in the scope of work. The Contractor shall suspend work until receiving direction from the Consultant. The Consultant shall promptly investigate the conditions and respond to the Contractor's notice with direction that avoids any unnecessary delay of the Work. The Consultant shall determine if the discovered conditions warrant a Change Order.
- 27.14 The Contractor shall, within ten calendar days of receipt of the information, give written notification to the Consultant if the Contractor claims that instructions by the Consultant will constitute extra cost not accounted for by Change Order or otherwise under the contract. The Consultant shall promptly respond to the Contractor's notice with direction that avoids any unnecessary delay of the Work. The Consultant shall determine if the Contractor's claim warrants a Change Order.

28. Correction of the Work

- 28.1 The Contractor shall promptly remove from the premises all work the Consultant declares is non-conforming to the contract. The Contractor shall replace the work properly at no expense to the Owner. The Contractor is also responsible for the expenses of others whose work was damaged or destroyed by such remedial work.
- 28.2 The Owner may elect to remove non-conforming work if it is not removed by the Contractor within a reasonable time, that time defined in a written notice from the Consultant. The Owner may elect to store removed non-conforming work not removed by the Contractor at the Contractor's expense. The Owner may, with ten days written notice, dispose of materials which the Contractor does not remove. The Owner may sell the materials and apply the net proceeds, after deducting all expenses, to the costs that should have been borne by the Contractor.
- 28.3 The Contractor shall remedy any defects due to faulty materials or workmanship and pay for any related damage to other work which appears within a period of one year from the date of substantial completion, and in accord with the terms of any guarantees provided in the contract. The Owner shall promptly give notice of observed defects to the Contractor and Consultant. The Consultant shall determine the status of all claimed defects. The Contractor shall perform all remedial work without unjustifiable delay in either the initial response or the corrective action.
- 28.4 The Consultant may authorize, after a reasonable notification to the Contractor, an equitable deduction from the contract amount in lieu of the Contractor correcting non-conforming or defective work.

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29. Owner's Right to do Work

- 29.1 The Owner may, using other contractors, correct deficiencies attributable to the Contractor, or complete unfinished work. Such action shall take place only after giving the Contractor three days written notice, and provided the Consultant approves of the proposed course of action as an appropriate remedy. The Owner may then deduct the cost of the remedial work from the amount due the Contractor.
- 29.2 The Owner may act with their sole discretion when the Contractor is unable to take action in emergency situations that potentially effect health, life or serious damage to the premises or adjacent properties, to prevent such potential loss or injury. The Owner shall inform the Contractor of the emergency work performed, particularly where it may affect the work of the Contractor.

30. Termination of Contract and Stop Work Action

- 30.1 The Owner may, owing to a certificate of the Consultant indicating that sufficient cause exists to justify such action, without prejudice to any other right or remedy and after giving the Contractor and the Contractor's surety seven days written notice, terminate the employment of the Contractor. At that time the Owner may take possession of the premises and of all materials, tools and appliances on the premises and finish the work by whatever method the Owner may deem expedient. Cause for such action by the Owner includes:
- .1 the contractor is adjudged bankrupt, or makes a general assignment for the benefit of its creditors, or
 - .2 a receiver is appointed due to the Contractor's insolvency, or
 - .3 the Contractor persistently or repeatedly refuses or fails to provide enough properly skilled workers or proper materials, or
 - .4 the Contractor fails to make prompt payment to Subcontractors or suppliers of materials or labor, or
 - .5 the Contractor persistently disregards laws, ordinances or the instructions of the Consultant, or is otherwise found guilty of a substantial violation of a provision of the Contract Documents.
- 30.2 The Contractor is not entitled, as a consequence of the termination of the employment of the Contractor as described above, to receive any further payment until the Work is finished. If the unpaid balance of the contract amount exceeds the expense of finishing the Work, including compensation for additional architectural, managerial and administrative services, such balance shall be paid to the Contractor. If the expense of finishing the Work exceeds the unpaid balance, the Contractor shall pay the difference to the Owner. The Consultant shall certify the expense incurred by the Contractor's default. This obligation for payment shall continue to exist after termination of the contract.
- 30.3 The Contractor may, if the Work is stopped by order of any court or other public authority for a period of thirty consecutive days, and through no act or fault of the Contractor or of anyone employed by the Contractor, with seven days written notice to the Owner and the Consultant, terminate this contract. The Contractor may then recover from the Owner payment for all work executed, any proven loss and reasonable profit and damage.
- 30.4 The Contractor may, if the Consultant fails to issue a certificate for payment within seven days after the Contractor's formal request for payment, through no fault of the Contractor, or if the

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Owner fails to pay to the Contractor within 30 days after submission of any sum certified by the Consultant, with seven days written notice to the Owner and the Consultant, stop the Work or terminate this Contract.

31. Delays and Extension of Time

- 31.1 The completion date of the contract shall be extended if the work is delayed by changes ordered in the work which have approved time extensions, or by an act or neglect of the Owner, the Consultant, or the Owner's Contractor, or by strikes, lockouts, fire, flooding, unusual delay in transportation, unavoidable casualties, or by other causes beyond the Contractor's control. The Consultant shall determine the status of all claimed causes.
- 31.2 The contract shall not be extended for delay occurring more than seven calendar days before the Contractor's claim made in writing to the Consultant. In case of a continuing cause of delay, only one claim is necessary.
- 31.3 The contract shall not be extended due to failure of the Consultant to furnish drawings if no schedule or agreement is made between the Contractor and the Consultant indicating the dates which drawings shall be furnished and fourteen calendar days has passed after said date for such drawings.
- 31.4 This article does not exclude the recovery of damages for delay by either party under other provisions in the Contract Document.

32. Payments to the Contractor

- 32.1 As noted under *Preconstruction Conference* in this section, the Contractor shall submit a Schedule of Values form, before the first application for payment, for approval by the Owner and Consultant. The Consultant may direct the Contractor to provide evidence that supports the correctness of the form. The approved Schedule of Values shall be used as a basis for payments.
- 32.2 The Contractor shall submit an application for each payment ("Requisition for Payment") on a form approved by the Owner and Consultant. The Consultant may require receipts or other documents showing the Contractor's payments for materials and labor, including payments to Subcontractors.
- 32.3 The Contractor shall submit Requisitions for Payment as the work progresses not more frequently than once each month, unless the Owner approves a more frequent interval due to unusual circumstances. The Requisition for Payment is based on the proportionate quantities of the various classes of work completed or incorporated in the Work, in agreement with the actual progress of the Work and the dollar value indicated in the Schedule of Values.
- 32.4 The Consultant shall verify and certify each Requisition for Payment which appears to be complete and correct prior to payment being made by the Owner. The Consultant may certify an appropriate amount for materials not incorporated in the Work which have been delivered and suitably stored at the site. The Contractor shall submit bills of sale, insurance certificates, or other such documents that will adequately protect the Owner's interests prior to payments being certified.

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- 32.5 In the event any materials delivered but not yet incorporated in the Work have been included in a certified Requisition for Payment with payment made, and said materials thereafter are damaged, deteriorated or destroyed, or for any reason whatsoever become unsuitable or unavailable for use in the Work, the full amount previously allowed shall be deducted from subsequent payments unless the Contractor satisfactorily replaces said material.
- 32.6 The Contractor may request certification of an appropriate dollar amount for materials not incorporated in the Work which have been delivered and suitably stored away from the site. The Contractor shall submit bills of sale, insurance certificates, right-of-entry documents or other such documents that will adequately protect the Owner's interests. The Consultant shall determine if the Contractor's documentation for the materials is complete and specifically designated for the Project. The Owner may allow certification of such payments.
- 32.7 Subcontractors may request, and shall receive from the Consultant, copies of approved Requisitions for Payment showing the amounts certified in the Schedule of Values.
- 32.8 Certified Requisitions for Payment, payments made to the Contractor, or partial or entire occupancy of the project by the Owner shall not constitute an acceptance of any work that does not conform to the Contract Documents. The making and acceptance of the final payment constitutes a waiver of all claims by the Owner, other than those arising from unsettled liens, from faulty work or materials appearing within one year from final payment or from requirements of the Drawings and Specifications, and of all claims by the Contractor, except those previously made and still unsettled.

33. Payments Withheld

- 33.1 The Owner shall retain five percent of each payment due the Contractor as part security for the fulfillment of the contract by the Contractor. The Owner may make payment of a portion of this "retainage" to the Contractor temporarily or permanently during the progress of the Work. The Owner may thereafter withhold further payments until the full amount of the five percent is reestablished. The Contractor may deposit with the Maine State Treasurer certain securities in place of retainage amounts due according to Maine Statute (5 M.R.S. §1746).
- 33.2 The Consultant may withhold or nullify the whole or a portion of any Requisitions for Payment submitted by the Contractor in the amount that may be necessary, in his reasonable opinion, to protect the Owner from loss due to any of the following:
- .1 defective work not remedied;
 - .2 claims filed or reasonable evidence indicating probable filing of claims;
 - .3 failure to make payments properly to Subcontractors or suppliers;
 - .4 a reasonable doubt that the contract can be completed for the balance then unpaid;
 - .5 liability for damage to another contractor.

The Owner shall make payment to the Contractor, in the amount withheld, when the above circumstances are removed.

34. Liens

- 34.1 The Contractor shall deliver to the Owner a complete release of all liens arising out of this contract before the final payment or any part of the retainage payment is released. The

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Contractor shall provide with the release of liens an affidavit asserting each release includes all labor and materials for which a lien could be filed. Alternately, the Contractor, in the event any Subcontractor or supplier refuses to furnish a release of lien in full, may furnish a bond satisfactory to the Owner, to indemnify the Owner against any lien.

- 34.2 In the event any lien remains unsatisfied after all payments to the Contractor are made by the Owner, the Contractor shall refund to the Owner all money that the latter may be compelled to pay in discharging such lien, including all cost and reasonable attorney's fees.

35. Workmanship

- 35.1 The Contractor shall provide materials, equipment, and installed work equal to or better than the quality specified in the Contract Documents and approved in submittal and sample. The installation methods shall be of the highest standards, and the best obtainable from the respective trades. The Consultant's decision on the quality of work shall be final.
- 35.2 The Contractor shall know local labor conditions for skilled and unskilled labor in order to apply the labor appropriately to the Work. All labor shall be performed by individuals well skilled in their respective trades.
- 35.3 The Contractor shall perform all cutting, fitting, patching and placing of work in such a manner to allow subsequent work to fit properly, whether that be by the Contractor, the Owner's Contractors or others. The Owner and Consultant may advise the Contractor regarding such subsequent work. Notwithstanding the notification or knowledge of such subsequent work, the Contractor may be directed to comply with this standard of compatible construction by the Consultant at the Contractor's expense.
- 35.4 The Contractor shall request clarification or revision of any design work by the Consultant, prior to commencing that work, in a circumstance where the Contractor believes the work cannot feasibly be completed at the highest quality, or as indicated in the Contract Documents. The Consultant shall respond to such requests in a timely way, providing clarifying information, a feasible revision, or instruction allowing a reduced quality of work. The Contractor shall follow the direction of the Consultant regarding the required request for information.
- 35.5 The Contractor shall guarantee the Work against any defects in workmanship and materials for a period of one year commencing with the date of the Certificate of Substantial Completion, unless specified otherwise for specific elements of the project. The Work may also be subdivided in mutually agreed upon components, each defined by a separate Certificate of Substantial Completion.

36. Close-out of the Work

- 36.1 The Contractor shall remove from the premises all waste materials caused by the work. The Contractor shall make the spaces "broom clean" unless a more thorough cleaning is specified. The Contractor shall clean all windows and glass immediately prior to the final inspection, unless otherwise directed.

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- 36.2 The Owner may conduct the cleaning of the premises where the Contractor, duly notified by the Consultant, fails to adequately complete the task. The expense of this cleaning may be deducted from the sum due to the Contractor.
- 36.3 The Contractor shall participate in all final inspections and acknowledge the documentation of unsatisfactory work, customarily called the "punch list", to be corrected by the Contractor. The Consultant shall document the successful completion of the Work in a dated Certificate of Substantial Completion, to be signed by Owner, Consultant, and Contractor.
- 36.4 The Contractor shall not call for final inspection of any portion of the Work that is not completely and permanently installed. The Contractor may be found liable for the expenses of individuals called to final inspection meetings prematurely.
- 36.5 The Contractor and all major Subcontractors shall participate in the end-of-warranty-period conference, typically scheduled close to one year after the Substantial Completion date.
37. Date of Completion and Liquidated Damages
- 37.1 The Contractor may make a written request to the Owner for an extension or reduction of time, if necessary. The request shall include the reasons the Contractor believes justifies the proposed completion date. The Owner may grant the revision of the contract completion date if the Work was delayed due to conditions beyond the control and the responsibility of the Contractor. The Contractor shall not conduct unauthorized accelerated work or file delay claims to recover alleged damages for unauthorized early completion.
- 37.2 The Contractor shall vigorously pursue the completion of the Work and notify the Owner of any factors that have, may, or will affect the approved Schedule of the Work. The Contractor may be found responsible for expenses of the Owner or Consultant if the Contractor fails to make notification of project delays.
- 37.3 The Project is planned to be done in an orderly fashion which allows for an iterative submittal review process, construction administration including minor changes in the Work and some bad weather. The Contractor shall not file delay claims to recover alleged damages on work the Consultant determines has followed the expected rate of progress.
- 37.4 The Consultant shall prepare the Certificate of Substantial Completion which, when signed by the Owner and the Contractor, documents the date of Substantial Completion of the Work or a designated portion of the Work. The Owner shall not consider the issuance of a Certificate of Occupancy by an outside authority a prerequisite for Substantial Completion if the Certificate of Occupancy cannot be obtained due to factors beyond the Contractor's control.
- 37.5 Liquidated Damages may be deducted from the sum due to the Contractor for each calendar day that the Work remains uncompleted after the completion date specified in the Contract or an approved amended completion date. The dollar amount per day shall be calculated using the Schedule of Liquidated Damages table shown below.

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If the original contract amount is:	The per day Liquidated Damages shall be:
Less than \$100,000	\$250
\$100,000 to less than \$2,000,000	\$750
\$2,000,000 to less than \$10,000,000	\$1,500
\$10,000,000 and greater	\$1,500 plus \$250 for each \$2,000,000 over \$10,000,000

38. Dispute Resolution

38.1 Mediation

38.1.1 A dispute between the parties which arises under this Contract which cannot be resolved through informal negotiation, shall be submitted to a neutral mediator jointly selected by the parties.

38.1.2 Either party may file suit before or during mediation if the party, in good faith, deems it to be necessary to avoid losing the right to sue due to a statute of limitations. If suit is filed before good faith mediation efforts are completed, the party filing suit shall agree to stay all proceedings in the lawsuit pending completion of the mediation process, provided such stay is without prejudice.

38.1.3 In any mediation between the Owner and the Consultant, the Owner has the right to consolidate related claims between Owner and Contractor.

38.2 Arbitration

38.2.1 If the dispute is not resolved through mediation, the dispute shall be settled by arbitration. The arbitration shall be conducted before a panel of three arbitrators. Each party shall select one arbitrator; the third arbitrator shall be appointed by the arbitrators selected by the parties. The arbitration shall be conducted in accordance with the Maine Uniform Arbitration Act (MUAA), except as otherwise provided in this section.

38.2.2 The decision of the arbitrators shall be final and binding upon all parties. The decision may be entered in court as provided in the MUAA.

38.2.3 The costs of the arbitration, including the arbitrators' fees shall be borne equally by the parties to the arbitration, unless the arbitrator orders otherwise.

38.2.4 In any arbitration between the Owner and the Consultant, the Owner has the right to consolidate related claims between Owner and Contractor.

010010 - DIVISION 01 FOR PROJECTS OF LIMITED SCOPE

1.1 DIVISION 01 CONTENTS

- A. Contents
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1.2 RELATED DOCUMENTS

- A. General provisions of Contract, including General Conditions apply to this Division and to Roofing Contractors (also known as Contractor and/or General Contractor), Subcontractors and other persons supplying materials and/or labor, entering into the Project site and/or premises, directly or indirectly.
- B. This Division is intended to provide additional details and procedures for the implementation of requirements prescribed in the Agreement.

1.3 SUMMARY OF WORK

- A. Project Description: The Project shall be known as “Dorothea Dix Building K Ventilation Upgrades”.

1. The Project consists of providing and installing a packaged ventilation unit with hot water heating, DX cooling and energy recovery on the roof of Building K. The ventilation unit will serve the first, second and third floors of Building K. The hot water heating coil will be served by a steam convertor and dedicated glycol hydronic system. The ventilation unit will connect to grilles installed under a separate project using vertical duct risers. The existing floor slabs will need to be cut to allow for the duct risers, and the openings framed with structural steel. The vertical duct risers will be boxed out on the second and third floors. As an alternate price, VRF heat recovery units will be tied into an existing system to serve the day rooms on the first, second and third floors of building K.
 - a. The Work shall include all labor, materials, supplies, equipment, components and systems required to complete the Project as specified and reasonably inferred by the Contract Documents, without exception, and all Work or portions of the Work normally required by accepted trade practices in projects of similar type, scope and locale, without which the Work could not be completed and without which the Work would not function properly.

- B. Contractor Use of Premises: Limit use of the premises to construction activities in areas indicated. Portions of the site beyond areas in which construction operations are indicated are not to be disturbed. Keep all driveways and entrances serving the premises clear at all times.
 1. The Owner will occupy the site and existing building during construction. Perform the Work so that interference with the Owner's operations is minimized and planned in advance.
 - a. Notify Owner at least 72 hours before any temporary interruption of utilities, safety or support systems.
 2. Provisions are to be made for the convenience, safety and comfort of staff and the public within all usable areas.
 3. Normal working hours for on-site activities shall be coordinated through Owner. Contractor may work on site after hours or weekends with Owner's approval.
 4. Keep all driveways and entrances serving the premises clear and available to the Owner, residence, staff and the public at all times. Do not use these areas for parking or material storage. Schedule deliveries to minimize on-site storage of materials and equipment.
 - a. Construction parking and material storage will be in designated areas only. Location to be determined by Owner.
 5. Smoking is prohibited anywhere on property.
 6. Do not dispose of any material on site, either by burial or by burning.

- C. Use of Existing Building: Maintain building in a weather-tight condition throughout the construction period. Take all precautions necessary to protect the building and its occupants during construction. Repair damage caused by construction operations.
 1. Provide dust-proof, weather tight, secure barriers between occupied and work areas of building.
 2. Use of existing toilets, wash rooms and other facilities within the existing building will not be allowed.
 3. Use of Owner's dumpsters will not be allowed.
 4. Keep all building entrances clear and accessible at all times.

- D. Owner Occupancy Requirements: The Owner will be responsible for operation, maintenance and custodial service for occupied portions of the building.

1.4 APPLICATIONS FOR PAYMENT

- A. Schedule of Values: Submit the fully completed Schedule of Values in a format approved by the Architect to the Architect no later than 7 days before the date scheduled for submittal of the initial Application for Payment.
1. Provide a breakdown of the Contract Sum in sufficient detail to facilitate continued evaluation of Applications for Payment.
- B. Applications for Payment: Progress payment dates and the period of construction Work covered by each Application for Payment.
1. Submit Application for Payment to the Owner and Architect so that the Application will be received by the Architect no later than 5 days prior to the indicated date for each progress payment.
 2. Payment Application Forms: Use AIA Documents G702 "Application and Certification for Payment" and G703 "Continuation Sheet" or another form acceptable to the Architect. Provide documentation and verification as required by Owner.
 3. Transmittal: Submit three (3) signed and notarized original copies of each Application for Payment to the Architect by means ensuring receipt within 48 hours. Each copy shall be complete.
 4. Waivers of Mechanics Lien: With final Application for Payment, submit waivers of mechanics lien from every entity who is lawfully entitled to file a lien related to the Work covered by the Payment.
 - a. Immediately upon receipt of final payment, Contractor shall execute waiver of mechanics lien for the period of construction covered by the application. Deliver so that Architect receives original executed waiver no later than three (3) days after receipt of payment by Contractor.
 - b. Submit final Application for Payment with or preceded by final waivers from every entity involved with the performance of the Work covered by the application who could lawfully be entitled to a lien.
 - 1) The total amount of each entity's final waiver of lien shall equal the contract sum for that entity including all additions and reductions thereto.
 5. Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of the first Application for Payment include the following:
 - a. List of subcontractors, principal suppliers and fabricators.
 - b. Schedule of Values.
 - c. List of Contractor's staff assignments.
 - d. Copies of building permits, if required by local jurisdiction.
 - e. Report of pre-construction meeting.
 - f. Certificates of insurance and insurance policies.
 - g. Performance and payment bonds.
 - h. Data needed to acquire Owner's insurance.
 6. Final Payment Application: This application shall reflect Certificates of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
 - a. Administrative actions and submittals which must precede or coincide with submittal of the final Application for Payment include the following:
 - 1) Completion of Project closeout requirements.
 - 2) Completion of items specified for completion after Substantial Completion.
 - 3) Assurance that unsettled claims will be settled.
 - 4) Assurance that Work not complete and accepted will be completed without undue delay.
 - 5) Proof that taxes, fees and similar obligations have been paid.

- 6) Removal of temporary facilities and services.
- 7) Removal of surplus materials, rubbish and similar elements.

1.5 CONTRACT MODIFICATION PROCEDURES

- A. Minor Changes in the Work
 1. Supplemental instructions authorizing minor changes in the Work, not involving an adjustment to the Contract Sum or Contract Time, may be issued by the Architect on AIA Document G710 "Architect's Supplemental Instructions" or other approved form.
- B. Change Order Proposal Requests
 1. Owner-Initiated Proposals: The Architect will issue a detailed description of proposed changes in the Work that will require adjustment to the Contract Sum or Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications. Proposal requests issued by the Architect are for information only.
 - a. Unless otherwise indicated in the proposal request, within 5 days of receipt of the proposal request, submit to the Architect for the Owner's review an itemized estimate of cost including related costs necessary to execute the proposed change.
 - 1) Include a statement indicating the effect the proposed change will have on the Contract Time.
 2. Contractor-Initiated Proposal: When latent or other unforeseen conditions require modifications to the Contract, the Contractor may propose changes by submitting a request for a change to the Architect.
 - a. Provide a complete description of proposed change. Indicate the reasons for the change and the effect of the change on the Work. Indicate the effect of the proposed change on the Contract Sum and Contract Time.
 - b. Include an itemized list of products required and unit costs along with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Comply with requirements for product substitutions if the proposed change in the Work requires the substitution of one product or system for a product or system specified.
- C. Construction Change Directive: When the Owner and Contractor are not in total agreement on the terms of a Change Order Proposal Request, the Architect may issue a Construction Change Directive on AIA G714 "Construction Change Directive", instructing the Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
 1. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive. After completion of the change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.
- D. Change Order Procedures: Upon the Owner's approval of a Change Order Proposal Request, the Architect, or the General Contractor if so required by the Architect, will issue a Change Order on AIA G701 "Change Order" for signatures of the Owner and Contractor, as provided in the Conditions of the Contract.
 1. Provide minimum of three (3) original copies with documentation, as required by Architect.

1.6 PROJECT COORDINATION

- A. Layout: The Contractor is responsible for all layout of all Work, even if such layout is done by others. The Contractor's responsibility includes but is not necessarily limited to levels, reference points, location of access panels, openings for light fixtures, ceiling grilles, sprinkler heads and other ceiling mounted devices, etc.
- B. Coordination: The Contractor shall coordinate construction activities included under various Sections of these Specifications to assure efficient and orderly demolition and installation of each part of the Work. The Contractor shall also coordinate construction operations included under different Specifications that are dependent upon each other for proper installation, connection, inspections and approvals, accessibility and operation.
- C. Superintendent: The Contractor's superintendent shall be on site at any time Work is being done.
- D. On-Site Documents: The Contractor shall provide in a visible and accessible location on the site:
 - 1. Complete, currently updated set of Specifications and Drawings, Change Orders and other Modifications, approved Shop Drawings, Product Data, Samples and similar submittals.
 - 2. Permits and notifications required by law, regulation, etc.
 - 3. List of Owner, Architect, Contractor, superintendent, subcontractors, etc. Include name of contact person, telephone and fax numbers. Include telephone numbers for police, ambulance and fire departments.
- E. Administrative Procedures: The Contractor shall coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and ensure orderly progress of the Work.
- F. General Installation Provisions:
 - 1. Inspection of Conditions: Require the Installer of each major component to inspect both the substrate and conditions under which Work is to be performed. Do not proceed until unsatisfactory conditions have been corrected to meet acceptable industry standards.
 - a. Should Contractor direct and require Installer to perform Work without correction of such unsatisfactory condition, Contractor shall be responsible for correction of any unacceptable Work resulting from conducting Work in such unsatisfactory condition.
 - 2. Recheck field measurements and dimensions, before starting each installation.
 - 3. Provide blocking, reinforcement, attachment and connection devices and methods necessary for securing Work. Secure Work true to line and level. Allow for expansion and building movement including any required expansion joints or device even if not detailed or shown.
 - 4. Alteration Projects: Remove, cut, and patch Work in a manner to minimize damage, to provide smooth transitions, and to provide means of restoring Products and finishes to specified condition.
 - a. Patch or replace portions of existing surfaces which are damaged, lifted, discolored, or showing other imperfections.
 - 5. During handling and installation, clean and protect construction in progress and adjoining materials in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

- a. Control accumulation of waste materials and rubbish. Remove from work areas at least daily.
 - b. Control dust and debris from construction work at all times so it will not adversely affect the condition of adjacent areas. Abutting areas and streets will be swept and kept clean of debris.
 - c. All temporary enclosures shall protect occupants, existing building and adjoining buildings, to minimize noise, dust, odors, rain, heat and cold from entering the existing buildings.
 - d. Clean and maintain completed construction as frequently as necessary through the remainder of the construction period.
 - e. Care shall be taken to avoid fumes entering into roof top unit intakes. Pay special attention to lower level roof adjoining this project.
6. Limiting Exposures: Supervise construction activities to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

1.7 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. Project name.
 2. Project number.
 3. Date.
 4. Name of Contractor.
 5. Name of Architect and Owner.
 6. RFI number, numbered sequentially.
 7. RFI subject.
 8. Specification Section number and title and related paragraphs, as appropriate.
 9. Drawing number and detail references, as appropriate.
 10. Field dimensions and conditions, as appropriate.
 11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 12. Contractor's signature.
 13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Architect.
1. Attachments shall be electronic files in PDF format.

- D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven working days for Architect's response for each RFI. RFIs received by Architect 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 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 "Contract Modification Procedures."
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect and Owner in writing within **10** 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. Use software log that is part of web-based Project software. Include the following:
1. Project name.
 2. Name and address of Contractor.
 3. Name and address of Architect and Owner.
 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 response was received.
 8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
 9. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.
- F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect and Owner within seven days if Contractor disagrees with response.
- 1.8 CUTTING AND PATCHING
- A. General: Employ skilled workmen to perform ripping, cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete without delay.
- B. Operational and Safety Limitations: Do not cut, patch or secure materials and elements in a manner that would reduce their capacity to perform as intended, or would increase maintenance, or decrease operational life or safety. Obtain approval before cutting and patching operating elements or safety related systems.

- C. Visual Requirements: Do not cut and patch construction exposed on the exterior, in a manner that would, in the Architect's opinion, reduce the building's aesthetic qualities, or result in visual evidence of cutting and patching. Remove and replace Work cut and patched in a visually unsatisfactory manner.
- D. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project that might be exposed during cutting and patching operations.
- E. Cutting: Cut existing construction using methods least likely to damage elements to be retained or adjoining construction. Where possible review procedures with the original installer; comply with the original installer's recommendations.
- F. Cleaning: Thoroughly clean areas and spaces where cutting and patching is performed or used as access. Remove completely paint, mortar, oils, putty and similar items. Thoroughly clean piping, conduit and similar features before painting or finishing is applied. Restore damaged pipe covering to its original condition.

1.9 REFERENCE STANDARDS & DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract. Definitions specific to individual Specifications are included in the appropriate Specification.
 - 1. "Inspect", "inspection" when used in conjunction with the Architect's activities is the visual observation of construction to permit the Architect to render his/her professional opinion as to whether the Contractor is performing the Work in a manner indicating that, when completed, the Work will be in accordance with the Contract Documents. Such observations shall not be relied upon by any party as acceptance of the Work, nor shall they relieve any party from fulfillment of customary and contractual responsibilities and obligations.
 - 2. "Certify", "certification" when used in conjunction with the Architect's observation of the Site and the work means the Architect's opinion based on his/her observation of conditions, knowledge, information and beliefs. It is expressly understood that the Architect's certification of a condition's existence relieves no other party of any responsibility or obligation he/she has accepted by contract or custom.
 - 3. "Furnish" means supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
 - 4. "Install" describes operations at the Project site including the actual unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
 - 5. "Provide" means to furnish and install, complete and ready for the intended use.
- B. Specifications:
 - 1. References: "Refer to" references to specific Articles or Paragraphs of the Agreement or to related Specifications are provided as a convenience to the Contractor to facilitate locating of relevant requirements, procedures, or Work. The references given may not be complete or may not be the only ones affecting the particular Specification or Paragraph wherein the reference is located.
 - a. The Contractor remains responsible for locating and complying with all relevant requirements and procedures specified in the Contract Documents.

- C. Industry 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 to the extent referenced. Such standards are made a part of the Contract Documents by reference.
 - 1. Copies of Standards: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to its construction activity. Where copies of standards are needed to perform a required construction activity, each entity is responsible for obtaining copies of each standard from the publication source.
- D. Governing Regulations and Regulations: The Contractor shall contact the authorities having jurisdiction prior to commencement of work and where necessary to obtain approvals if required.
- E. 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.

1.10 PROJECT MEETINGS

- A. Preconstruction Conference: The Contractor shall schedule a preconstruction conference and organizational meeting at the project site or other convenient location prior to commencement of construction activities. Conduct the meeting to review responsibilities and personnel assignments. The Owner will review use of site and Contract requirements.
 - 1. Attendees: The Owner, the Contractor and his superintendent, major subcontractors, manufacturers, suppliers and other concerned parties shall each be represented at the conference by persons familiar with and authorized to conclude matters relating to the Work.
 - 2. Reporting: No later than 3 days after the preconstruction conference, the Contractor shall submit a report to the Owner and Architect for review. After revision by the Owner and Architect, if any, the Contractor shall distribute copies of minutes of the meeting to each party present and to other parties who should have been present, including the Owner and Architect
- B. Progress Meetings: The Contractor shall conduct progress meetings at the project site at intervals as required. Notify the Owner and Architect of scheduled meeting dates. Coordinate dates of meetings with preparation of the payment requests.
 - 1. Reporting: No later than 3 days after each progress meeting date, the Contractor shall submit a report to the Architect for review. After revision by Architect, if any, the Contractor shall distribute copies of minutes of the meeting to each party present and to other parties who should have been present including the Owner.
 - a. Include a brief summary, in narrative form, of progress of Work since the previous meeting and report.
 - b. Do not remove items from reports until they have been resolved.
- C. Special Attendance at Meetings: The Owner, Owner's Designated Representative or Architect may require the attendance of a particular party or parties at any project meeting or conference.

1.11 SUBMITTAL PROCEDURES

- A. Electronic Submittals: **Architect is using Newforma software to process electronic submittals.** Identify and incorporate information in each electronic submittal file as follows:
1. Assemble complete submittal package into single files incorporating submittal requirements of a single specification section and transmittal form.
 - a. Provide a separate transmittal form for Product Data, a separate transmittal form for Shop Drawings, and a separate transmittal form for Informational Submittals required by each Specification Section.
 - b. Maximum File Size: A single file size, up to 18 MB can be received. Contact Architect for instructions if file exceeds 18 MB.
 - c. For each transmittal, attach one single PDF only. Where multiple PDFs are required for a transmittal, utilize Adobe Acrobat combine feature to merge the PDFs into a single PDF.
 - 1) Unacceptable Formats: In order to process the transmittals in Newforma, the single PDF file protocol must be followed. Transmittals zip files or grouped PDFs cannot be electronically processed and will be returned without action for correction and resubmittal.
 - 2) Submittals will be returned without action for correction and resubmittal if:
 - a) Submittal does not have an electronic Transmittal Form.
 - b) Multiple specification sections are contained within a single Transmittal form. Submittals must be separated into individual Specification Sections.
 2. Name file with submittal number or other unique identifier, including revision identifier.
 - a. File name shall use project identifier and Specification Section number followed by a dash and then a sequential number (e.g., LNHS-061000-01). Resubmittals shall include an alphabetic suffix after another dash (e.g., LNHS-061000-01-A).
 3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.
 4. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Owner, containing the following information:
 - a. Project name.
 - b. Date.
 - c. Name and address of Architect.
 - d. Name of Owner.
 - e. Name of Contractor.
 - f. Name of firm or entity that prepared submittal.
 - g. Names of subcontractor, manufacturer, and supplier.
 - h. Category and type of submittal.
 - i. Submittal purpose and description.
 - j. Specification Section number and title.
 - k. Specification paragraph number or drawing designation and generic name for each of multiple items.
 - l. Drawing number and detail references, as appropriate.
 - m. Location(s) where product is to be installed, as appropriate.
 - n. Related physical samples submitted directly.
 - o. Indication of full or partial submittal.
 - p. Transmittal number.
 - q. Submittal and transmittal distribution record.
 - r. Other necessary identification.

- B. Shop Drawings: Shop Drawings include fabrication and installation drawings, seam locations, and similar drawings.
1. Submit newly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Standard information prepared without specific reference to the Project is not considered Shop Drawings.
 2. Sheet Size: Except for templates, patterns and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2" x 11" but no larger than 24" x 36".
 3. Submittal: Submit five (5) black-line prints for the Architect's review; three (3) prints will be marked up and returned.
 - a. One returned marked-up print shall be maintained as a "Record Document".
- C. Required Stamps: Do not use or take on Site Shop Drawings without an Architect/Engineer action stamp present in connection with construction.
- D. Product Data
1. Products Specified by Manufacturer and Model Number: For products specifically indicated by manufacturer and model number which will be provided as specified with no deviations, submit for approval a letter for each product certifying that it will be provided as specified with no deviations from Contract Documents. Also submit product data at time of Project completion as required for project closeout. For all other products, submit product data as required below.
 2. Collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information such as manufacturer's installation instructions, catalog cuts, material test reports, and performance.
 - a. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products, some of which are not required, mark copies to indicate the applicable information.
 - b. Submittals: Submit five (5) copies of each required submittal. The Architect will retain two (2), and will return the others marked with action taken and corrections or modifications required.
 - c. Distribution: Furnish copies of final submittal to installers, subcontractors, suppliers, manufacturers, fabricators, and others required for performance of construction activities. Show distribution on transmittal forms.
 - 1) Do not proceed with installation until an applicable copy of Product Data is in the installer's possession.
 - 2) Do not permit use of unmarked copies of Product Data without Architect indicating action taken is attached in connection with construction.
- E. Samples: Unless otherwise directed by the Architect, submit full-size, fully fabricated samples of roof edge and frieze board wrap.
1. Submittals: Submit two (2) sets; one (1) will be returned marked with the action taken.
 - a. Maintain sets of Samples, as returned, at the Project site, for quality comparisons throughout the course of construction.
 - b. Comply with submittal requirements to the fullest extent possible. Process transmittal forms to provide a record of activity.
- F. Manufacturer's Instructions: When specified in individual Specifications or specifically requested by Architect, submit printed instructions for delivery, storage, assembly, and installation to Architect in quantities specified for Product Data.

- G. Architect's Action: Except for submittals for record, information or similar purposes, where action and return is required or requested, the Architect will review each submittal, mark to indicate action taken, and return promptly.
1. Architect's Approval Stamp: The Architect, where required, will complete the Architect's Action portion of the stamp which will be appropriately marked, as follows, to indicate the action taken and comments may be provided:
 - a. Final Unrestricted Release: Where submittals are marked "Approved", that part of the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents; final acceptance will depend upon that compliance.
 - b. Final-But-Restricted Release: When submittals are marked "Approved as Noted", that part of the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents; final acceptance will depend on that compliance.
 - c. Returned for Resubmittal: When submittal is marked "Not Approved, Revise and Resubmit", do not proceed with that part of the Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal in accordance with the notations; resubmit without delay. Repeat if necessary to obtain a different action mark.
 - 1) Do not permit submittals marked "Not Approved, Revise and Resubmit" to be used at the Project site, or elsewhere where Work is in progress.
 - d. Rejected: When submittal is marked "Rejected", do not proceed with that part of the Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Do not resubmit that product.
 - e. Other Action: Where a submittal is primarily for information or record purposes, special processing or other activity, the submittal will be returned, stamped "Received for information only".
 2. Any sample, shop drawing, or other item requiring Architect's approval, or copy thereof, that does not have a copy of Architect's approval attached, shall be considered as not having been approved.

1.12 TEMPORARY FACILITIES

- A. Submittals: Submit reports of tests, inspections, meter readings and similar procedures performed on temporary utilities.
- B. Quality Assurance:
 1. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction.
 2. Standards: Comply with NFPA Code 241, "Building Construction and Demolition Operations", ANSI-A10 Series standards for "Safety Requirements for Construction and Demolition".
- C. Temporary Utility Usage: Engage the appropriate local utility company to install temporary service or connect to existing service.
 1. Use Charges: Contractor may use existing electrical service and use charges will be paid by Owner. Coordinate with Owner prior to connection.
 2. Water Service: Contractor may use existing electrical service and use charges will be paid by Owner. Coordinate with Owner prior to connection.

3. Temporary Lighting: Install and operate temporary lighting that will fulfill security and protection requirements, without operating the entire system, and will provide adequate illumination for construction operations and traffic conditions.
4. Temporary Telephones: Provide temporary telephone service at site for all personnel engaged in construction activities, throughout the construction period.
5. Parking: Arrange with Owner for temporary parking areas to accommodate construction personnel and visitors.
6. Sanitary facilities: Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking-water fixtures. Comply with regulations and health codes for type, number, location, operation, and maintenance of fixtures and facilities Contractor shall not use existing toilets in the facility.
 - a. Maintain daily in clean and sanitary condition.
7. Collection and Disposal of Waste: Collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose of material in a lawful manner.
 - a. Empty dumpster when full. Do not overfill or allow debris to blow around area. Keep area around dumpster free of trash, glass, nails, etc.
 - b. Burying or burning of waste materials on the site will not be permitted. Washing waste materials down sewers or into drainage waterways will not be permitted.

D. Security and Protection Facilities Installation:

1. Temporary Fire Protection: Comply with NFPA 10 “Standard for Portable Fire Extinguishers” and NFPA 241 “Standard for Safeguarding Construction, Alterations and Demolition Operations”.
 - a. Locate fire extinguishers where convenient and effective for their intended purpose.
 - b. Maintain unobstructed access to fire extinguishers and access routes for fighting fires.
2. Barricades, Warning Signs and Lights: Comply with standards and code requirements for erection of structurally adequate barricades. Paint with appropriate colors, graphics and warning signs to inform personnel and the public of the hazard being protected against. Where appropriate and needed provide lighting, including flashing red or amber lights.
3. Security Enclosure and Lockup: Maintain locked entrances to prevent unauthorized entrance, theft and vandalism, and similar violations of security.
 - a. Storage: Where materials and equipment must be stored, and are of value or attractive for theft, provide a secure lockup. Enforce discipline in connection with the installation and release of material to minimize the opportunity for theft and vandalism.
4. Environmental Protection: Provide protection, and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.

E. Materials and Equipment:

1. Submittals:

- a. Schedule of Long Lead Time Items: The General Contractor shall provide the Architect with a schedule of all long lead items for review and approval prior to ordering. Once approved, the General Contractor shall pre-order items in a timely manner as not to delay the progress of the Work.
2. Quality Assurance:
 - a. Source Limitations: To the fullest extent possible, provide products of the same kind, from a single source.
 - b. Compatibility of Options: When the General Contractor is given the option of selecting between two or more products for use on the Project, the product selected shall be compatible with products previously selected, even if previously selected products were also options.
 - 1) Provide interchangeable components of the same manufacture for components being replaced.
3. Product Delivery, Storage, and Handling: Deliver, store and handle products in accordance with the manufacturer's written recommendations, using means and methods that will prevent damage, deterioration and loss, including theft.
 - a. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft and other losses.
 - b. Deliver products to the site in the manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting and installing.
 - c. Inspect products upon delivery to ensure compliance with the Contract Documents, and to ensure that quantities are correct and that products are undamaged and properly protected.
 - d. Inspect products for damage when removed from storage area. Repair or replace damaged products before installation. Manufacturer's representative shall certify all repairs as meeting manufacturer's original standards.
4. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, unused at the time of installation.
 - a. Provide products complete with all accessories, trim, finish, and details needed for a complete installation and for the intended use and effect.
 - b. Standard Products: Where available, provide standard products of types that have been produced and used successfully in similar situations on other projects, except where otherwise specified.
5. Product Selection Procedures: Product selection is governed by the Contract Documents and governing regulations, not by previous experience. Procedures governing product selection include the following:
 - a. Proprietary Specification Requirements: Where only a single product or manufacturer is named, provide the product indicated. No substitutions will be permitted.
 - b. Semiproprietary Specification Requirements: Where two or more products or manufacturers are named, provide one of the products indicated. No substitutions will be permitted.
 - 1) "Or Equal" Specification Requirements: Where products or manufacturers are specified by name, accompanied by the term "or equal," or "or approved equal" comply with the Contract Document provisions concerning "substitutions" or obtain approval for use of an unnamed product.
 - c. Descriptive Specification Requirements: Where Specifications describe a product or assembly, listing exact characteristics required, with or without use of a brand or

- trade name, provide a product or assembly that provides the characteristics and otherwise complies with Contract requirements.
- d. Performance Specification Requirements: Where Specifications require compliance with performance requirements, provide products that comply with these requirements, and are recommended by the manufacturer for the application indicated. General overall performance of a product is implied where the product is specified for a specific application.
 - 1) Manufacturer's written recommendations may be contained in published product literature, or by the manufacturer's certification of performance.
 - e. Compliance with Standards, Codes and Regulations: Where the Specifications only requires compliance with an imposed code, standard or regulation, select a product that complies with the standards, codes or regulations specified.
6. Installation of Products: Comply with manufacturer's written instructions and recommendations for installation of products in the applications indicated. Anchor each product securely in place, accurately located and aligned with other Work.
- a. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

1.13 PRODUCT SUBSTITUTIONS

- A. "Substitutions" are requests for changes in products, materials, equipment, and methods of construction required by Contract Documents proposed by the General Contractor after the Notice to Proceed. The following are not considered substitutions:
- 1. Substitutions requested by Bidders during the bidding period, and accepted prior to the Notice to Proceed, are considered as included in the Contract Documents and are not subject to requirements specified in this Section for substitutions.
 - 2. Revisions to Contract Documents requested by the Owner or Architect.
 - 3. Specified options of products and construction methods included in Contract Documents.
 - 4. The General Contractor's determination of and compliance with governing regulations and orders issued by governing authorities.
- B. Substitution Request Submittal: Requests for substitution will be considered if, in the opinion of the Architect, such substitution will be of benefit to the Owner.
- 1. Submit 3 copies of each request for substitution for consideration. Submit requests in the form and in accordance with procedures required for Change Order proposals.
 - a. Attach completed "Contractor/General Contractor's Substitutions Checklist" to each request for substitution. Forms to be obtained from Architect.
 - 2. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
 - a. Product Data, including drawings, specification sheets, and descriptions of products, fabrication and installation procedures.
 - b. Samples, where applicable.
 - c. Product specifications and samples of the specified products for comparison.
 - d. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.

- e. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors, that will become necessary to accommodate the proposed substitution.
 - f. A statement indicating the substitution's effect on the General Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
 - g. Cost information, including additional cost or savings in other parts of the Work resulting from the proposed substitution and a proposal of the net change, if any in the Contract Sum.
 - h. Certification by the General Contractor that the substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the General Contractor's waiver of rights to additional payment or time, that may subsequently become necessary because of the failure of the substitution to perform adequately.
3. Architect's Action: Within one week of receipt of the request for substitution, the Architect may request additional information or documentation necessary for evaluation of the request. Within 1 weeks of receipt of the request, or one week of receipt of the additional information or documentation, which ever is later, the Architect will notify the General Contractor of acceptance or rejection of the proposed substitution. If a decision on use of a proposed substitute cannot be made or obtained within the time allocated, use the product specified by name. Acceptance will be in the form of a Change Order.
- C. Conditions: The General Contractor's substitution request will be received and considered by the Architect when one or more of the following conditions are satisfied, as determined by the Architect; otherwise requests will be returned without action except to record noncompliance with these requirements.
1. Extensive revisions to Contract Documents are not required.
 2. Proposed changes are in keeping with the general intent of Contract Documents.
 3. The request is timely, fully documented and properly submitted.
 4. The request is directly related to an "or equal" clause or similar language in the Contract Documents.
 5. The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.
 6. The specified product or method of construction cannot receive necessary approval by a governing authority, and the requested substitution can be approved.
 7. A substantial advantage is offered the Owner, in terms of cost savings, time savings, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear.
 8. The specified product or method of construction cannot be provided in a manner that is compatible with other materials, and where the General Contractor certifies that the substitution will overcome the incompatibility.
 9. The specified product or method of construction cannot be coordinated with other materials, and where the General Contractor certifies that the proposed substitution can be coordinated.
 10. The specified product or method of construction cannot provide a warranty required by the Contract Documents and where the General Contractor certifies that the proposed substitution provide the required warranty.

- D. The General Contractor's submittal and Architect's acceptance of Shop Drawings, Product Data or Samples that relate to construction activities not complying with the Contract Documents does not constitute an acceptable or valid request for substitution, nor does it constitute approval.

1.14 PROJECT CLOSEOUT

A. Completion:

1. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Architect's review.
2. Inspection Procedures: On receipt of a request for inspection, the Architect and Owner will either proceed with inspection or advise the General Contractor of unfilled requirements. The Architect will prepare following inspection, or advise the General Contractor of construction that must be completed or corrected before the certificate will be issued.

B. Closeout Procedure:

1. Preliminary Procedures: Before requesting final inspection for certification of final acceptance and final payment, complete the following. List exceptions in the request.
 - a. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include final waivers of lien, and 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's final inspection list of items to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance and the list has been endorsed and dated by the Architect.
 - d. Submit record drawings, maintenance manuals, final project photographs, damage or settlement survey, and similar final record information.
 - e. Submit consent of surety to final payment on AIA G707 "Consent of Surety to Final Payment".

C. Record Document Submittals:

1. Record Drawings: Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Show the actual installation where the installation varies substantially from the Work as originally shown. Mark drawings to show conditions fully and accurately; where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.
 - a. Mark record sets with red non-erasable pencil and notes, details or sketches which are affected.
 - b. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.
 - c. Note related Change Order numbers where applicable.
2. Miscellaneous Record Submittals: Refer to other Specifications for requirements of miscellaneous record-keeping and submittals in connection with actual performance of the Work. Immediately prior to the date or dates of Completion, complete miscellaneous

- records and place in good order, properly identified and bound or filed, ready for continued use and reference. Submit to the Architect for the Owner's records.
3. Maintenance Manuals: Organize maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty, 3-ring vinyl-covered binders, with pocket folders for folded sheet information. Mark appropriate identification on front and spine of each binder.
- D. Final Cleaning: Employ experienced workers for final cleaning. Clean roof surface to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
1. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
 - a. Remove labels that are not permanent labels.
 - b. Wipe surfaces of mechanical equipment.
 - c. Clean the site, including landscape development areas, of rubbish, litter and other foreign substances.
- E. Compliance: Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful or dangerous materials into drainage systems. Remove waste materials from the site and dispose of in a lawful manner.

1.15 WARRANTIES AND BONDS

- A. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the General Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the General Contractor.
- B. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- C. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- D. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The General Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefitted from use of the Work through a portion of its anticipated useful service life.
- E. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.
1. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.

- F. Owner's Right of Refusal: The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.
- G. Commencement Date of Warranties: Date of Certificate of Substantial Completion designates a commencement date for warranties.
- H. Form of Submittal: At Final Completion compile two copies of each required warranty and bond properly executed by the General Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.
 - 1. Refer to individual Specifications for specific content requirements, and particular requirements for submittal of special warranties.
 - 2. Verify that documents are in proper form, contain full information, and are notarized. Co-execute submittals when required.
 - 3. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

END OF DIVISION 01

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SECTION 012300 - ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

- A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to or deducted from the Base Bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
 - 1. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.
 - 2. Hold pricing for 60 days from date of bid to allow Owner time for project accounting. Alternates not accepted before contract signing may be added by Change Order later.

1.4 PROCEDURES

- A. Coordination: Modify or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
 - 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to alternates.
- C. Execute accepted alternates under the same conditions as other work of the Contract.
- D. Schedule: A Schedule of Alternates is included at the end of this Section.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

- A. Alternate No.1 – Providing and installing VRV indoor units to tie into existing refrigerant piping at the first, second and third floors of Building K. These units will be powered from existing VRF equipment adjacent to the locations where the new units are shown on the plans. The intent is to install all VRF equipment at the same time so that the refrigerant will only need to be evacuated once from the system.

END OF SECTION 012300

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
 - 2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For dimpled steel studs and runners and fire-stop tracks, from ICC-ES.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 FRAMING SYSTEMS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.
- B. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
 - 2. Protective Coating: ASTM A 653/A 653M, G60 (Z180) hot-dip galvanized unless otherwise indicated.

- C. Studs and Runners: ASTM C 645. Use either steel studs and runners or dimpled steel studs and runners.
1. Steel Studs and Runners:
 - a. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).
 - b. Depth: As indicated on Drawings.
 2. Dimpled Steel Studs and Runners:
 - a. Minimum Base-Metal Thickness: 0.025 inch (0.64 mm).
 - b. Depth: As indicated on Drawings.
- D. Slip-Type Head Joints: Where indicated, provide one of the following (or approved equal):
1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch- (51-mm-) deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches (305 mm) of the top of studs to provide lateral bracing.
 2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- (51-mm-) deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
 3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - a. Products: Subject to compliance with requirements, provide one of the following or equal:
 - 1) Dietrich Metal Framing; SLP-TRK Slotted Deflection Track.
 - 2) MBA Building Supplies; Slotted Deflecto Track.
 - 3) Steel Network Inc. (The); VertiClip SLD Series.
 - 4) Superior Metal Trim; Superior Flex Track System (SFT).
 - 5) Telling Industries; Vertical Slip Track II.
- E. Cold-Rolled Channel Bridging: Steel, 0.053 inch (1.34 mm) minimum base-metal thickness, with minimum 1/2 inch (13 mm) wide flanges.
1. Depth: As indicated on Drawings
 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068 inch (1.72 mm) thick, galvanized steel.

2.3 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048 inch (1.21 mm) diameter wire.
- B. Hanger Attachments to Concrete:
1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to five (5) times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.
 - a. Type: Post-installed, chemical anchor or Post-installed, expansion anchor as existing conditions warrant.
 2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to ten (10) times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.

- C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.
- D. Flat Hangers: Steel sheet, 1 by 3/16 inch (25 by 5 mm) by length indicated required.

2.4 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 - 1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding-power, and other properties required to fasten steel members to substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
 - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
 - 1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
 - 2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
 - 3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
 - 4. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, wall guard rails, accessories, furnishings, or similar construction.
- C. Install bracing at terminations in assemblies.
- D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacing indicated, but not greater than spacing required by referenced installation standards for assembly types.
 - 1. Single-Layer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
 - 1. 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.

3.5 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Hangers: 32 inches (1219 mm) o.c.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 - 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 - 4. 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.

- E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
- F. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

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SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior gypsum board.

1.3 ACTION SUBMITTALS

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

1.4 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Fire-Resistance-Rated Assemblies: Indicated by design designations from UL's "Fire Resistance Directory," GA-600, "Fire Resistance Design Manual," or in the listing of another testing and inspecting agency acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE AND HANDLING

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

1.6 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

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

2.3 INTERIOR GYPSUM BOARD

- A. Gypsum Board, Type X: ASTM C 1396/C 1396M.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Georgia-Pacific Building Products.
 - b. National Gypsum Company.
 - c. USG Corporation.
 - 2. Thickness: 5/8 inch (15.9 mm).
 - 3. Long Edges: Tapered

2.4 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
 - 1. Material: Galvanized steel.
 - 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.

2.5 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 - 1. Interior Gypsum Board: Paper.
 - 2. 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, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.

2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping or drying-type, all-purpose compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
3. Fill Coat: For second coat, use setting-type, sandable topping or drying-type, all-purpose compound.
4. Finish Coat: For third coat, use setting-type, sandable topping or drying-type, all-purpose compound.

2.6 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- D. Form control and expansion joints with space between edges of adjoining gypsum panels.

- E. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
- F. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- G. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 - 1. Wallboard Type: As indicated on Drawings
- B. Single-Layer Application:
 - 1. On ceilings, apply gypsum panels at right angles to framing unless otherwise indicated.
 - 2. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

3.4 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.
 - 1. Review locations of control joints with Architect prior to start of gypsum panel installation.
- C. Interior Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners
 - 2. LC-Bead: Use where gypsum panels are tightly abutted to other construction and back flange can be attached to framing or supporting substrate.
 - 3. U-Bead: Use at exposed panel edges

3.5 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges] and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 - 1. Level 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."
- E. Glass-Mat, Water-Resistant Backing Panels: Finish board forming base for ceramic and porcelain tile to comply with ASTM C 840 and according to
- F. For Level 4 gypsum board finish, embed tape in joint compound and apply first, fill (second), and finish (third) coats of joint compound over joints, angles, fastener heads, and accessories. Touch up and sand between coats and after last coat as needed to produce a surface free of visual defects and ready for decoration.
 - 1. At tapered edge joints, draw compound down to a level plane, leaving a monolithic surface that is flush with paper face. Finish coat shall be feathered a minimum of 8 inches beyond both sides of center of joint tape.
 - 2. At end-to-end butt joints, draw compound down to minimize hump created by joint tape application. Finish coat shall be feathered a minimum of 16 inches beyond both sides of center of joint tape.
 - 3. End product shall be a surface that appears level without telegraphing joint locations as high spots when viewed down wall after painting.
 - 4. Finish board to within 1/4 inch of floor, providing full support for resilient wall base without telegraphing joint.

3.6 FIELD QUALITY CONTROL

- A. Above-Ceiling Observation: Before Contractor installs gypsum board ceilings, Architect will conduct an above-ceiling observation and report deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected.
 - 1. Notify Architect seven days in advance of date and time when Project, or part of Project, will be ready for above-ceiling observation.
 - 2. Before notifying Architect, complete the following in areas to receive gypsum board ceilings:
 - a. Installation of 80 percent of lighting fixtures, powered for operation.
 - b. Installation, insulation, and leak and pressure testing of water piping systems.
 - c. Installation of air-duct systems.
 - d. Installation of air devices.
 - e. Installation of mechanical system control-air tubing.
 - f. Installation of above ceiling automatic fire suppression piping, including leak and pressure testing.
 - g. Installation of ceiling support framing.
 - h. Installation of fire stopping, smoke sealant and acoustical sealant work.

3.7 CLEANING

- A. Promptly remove any residual joint compound from adjacent surfaces.

3.8 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 096513 - RESILIENT BASE AND 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.

1.2 SUMMARY

- A. Section Includes:
 - 1. Resilient base.

1.3 ACTION SUBMITTALS

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

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Furnish not less than 10 linear feet (3 linear m) > for every 500 linear feet (150 linear m) or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 QUALITY ASSURANCE

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C).

1.7 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive resilient products during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC-RUBBER BASE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Johnsonite; A Tarkett Company.
- B. Product Standard: ASTM F 1861, Type TP (rubber, thermoplastic).
 - 1. Group: I (solid, homogeneous).
 - 2. Style and Location:
 - a. Style B, Cove: Provide in areas with resilient flooring.
- C. Thickness: 0.125 inch (3.2 mm).
- 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 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.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

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

3.3 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Job-Formed Corners:
 - 1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches (76 mm) 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 (76 mm) in length.
 - a. Miter or cope corners to minimize open joints.

3.4 CLEANING AND PROTECTION

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

END OF SECTION 096513

SECTION 099123 - INTERIOR PAINTING

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 surface preparation and the application of paint systems on interior substrates.

1.3 DEFINITIONS

- A. Semi-gloss refers to a high sheen finish, MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Indicate VOC content.Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
 - 1. Samples: For each type of exposed finish required, submit color chips, 3- by 5-inches, matching colors indicated on Finish Schedule
- C. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations and wet film thickness.
- D. Qualification Data: For Applicator.
- E. Color Mix Code: For all colors used for Project to include in Owner's Manual.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Paint: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.6 QUALITY ASSURANCE

- A. Applicator Qualifications: Engage an experienced Applicator who has completed painting system applications similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

- B. Source Limitations: Obtain block fillers, primers and undercoat materials for each coating system from the same manufacturer as the finish coats.
- C. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
 - b. Other Items: Architect will designate items or areas required.
 - 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the Project Site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information:
 - 1. Product name or title of material.
 - 2. Product description (generic classification or binder type).
 - 3. Manufacturer's stock number and date of manufacture.
 - 4. Contents by volume, for pigment and vehicle constituents.
 - 5. Thinning instructions.
 - 6. Application instructions.
 - 7. Color name and number.
- B. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

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. PPG Architectural Finishes, Inc.
3. Sherwin-Williams Company (The).

- B. Products: Subject to compliance with requirements, provide one of the products listed in the Interior Painting Schedule for the paint category indicated.

2.2 PAINT, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

- B. 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.

- C. VOC Content: For field applications that are inside the weatherproofing system, paints and coatings shall 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: 50 g/L.
3. Primers, Sealers, and Undercoaters: 100 g/L.
4. Rust-Preventive Coatings: 100 g/L.

- D. Colors: As indicated in a color schedule.

1. Zero percent of surface area will be painted with deep tones.

2.3 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Percentages in six subparagraphs below are based on "MPI Manual."
 - 2. Concrete: 12 percent.
 - 3. Fiber-Cement Board: 12 percent.
 - 4. Masonry (Clay and CMUs): 12 percent.
 - 5. Wood: 15 percent.
 - 6. Gypsum Board: 12 percent.
 - 7. Plaster: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- E. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" 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.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Coordination of shop-applied prime coats with topcoats is critical.
 - 2. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

- F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
 - 1. SSPC-SP 7/NACE No. 4.
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- I. Aluminum Substrates: Remove loose surface oxidation.
- J. Wood Substrates:
 - 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
 - 2. Sand surfaces that will be exposed to view, and dust off.
 - 3. Prime edges, ends, faces, undersides, and backsides of wood.
 - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- K. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 FIELD QUALITY CONTROL

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

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

- A. Gypsum Board: Provide the following finish systems over interior gypsum board ceilings:
 - 1. Semigloss, Acrylic-Latex Finish: 2 finish coats over a primer.
 - a. Primer: Latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Moore: Fresh Start Premium Interior Primer No. N23; 1.2 mils DFT.
 - 2) PPG: Speedhide Zero Interior Zero-VOC Latex Sealer, 6-4900XI series; 1.2 mils DFT.
 - 3) S-W: ProMar 200 Zero VOC Interior Latex Primer B28W02600 Series; 1.5 mils DFT.
 - 4) Note: Verify bond of primer to existing semi-gloss and gloss hard, slick surfaces. Where full bond of specified primer does not occur, provide a bonding primer.
 - b. First and Second Coats: Semigloss, interior acrylic-latex, interior finish applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Moore: Ben Zero-VOC Interior Latex Semi-Gloss No. 627; 1.5 mils DFT per coat.
 - 2) PPG: Speedhide Zero Interior Zero-VOC Latex Semi-Gloss, 6-4510XI Series; 1.3 mils DFT per coat.
 - 3) S-W: ProMar 200 Zero VOC Interior Latex Semi-Gloss, B31W02651Series; 1.5 DFT per coat.

END OF SECTION 099123

SECTION 230500 – COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Provide labor, materials, accessories, and other related items as required to complete operations in connection with the complete installation of the HVAC and mechanical systems as indicated on the Drawings and as specified herein.

1.2 RELATED REQUIREMENTS

- A. Conditions of the Contract apply to the work, including the work of this Division. Examine Contract Documents for requirements affecting the work.

1.3 DRAWINGS

- A. The general location of the apparatus and the details of the work are indicated on the Drawings. Exact locations not indicated shall be determined at the site as the work progresses and shall be subject to the Architect's approval.
- B. It is not intended that the Drawings shall show every pipe, pipe rise, pipe drop, duct rise, duct drop, pipe fitting, duct fitting, or appliance, but it shall be a requirement to furnish, without additional expense, material and labor necessary to complete the systems in accordance with the design intent and with the highest possible quality available.

1.4 ALTERATIONS

- A. Execute alterations, additions, removals, relocations, new work, and other related items as indicated or required to provide a complete installation in accordance with the intent of the Contract Documents, including changes required by building alterations.
- B. Existing work disturbed or damaged by the alterations or the new work shall be repaired or replaced to the Architect's satisfaction and at no additional cost to the Owner.
- C. Existing ductwork, piping, and other systems indicated to be removed, shall be removed from the site. Cap off existing services remaining. The Owner retains the right to ownership of heating and ventilating equipment scheduled to be removed; store such equipment where requested by the Owner. Material not retained by the Owner shall be removed from the site.

1.5 CONTINUITY OF SERVICE

- A. Arrange to execute the work at such times and in such locations as may be required to provide uninterrupted service for the building or any of its locations. Any unavoidable conditions requiring reduced building capacity shall be arranged for by programming with the Owner's duly authorized representative at the building subject to the Architect's approval. If necessary, temporary work shall be installed to provide for the condition. Authorization for interrupting service shall be obtained in writing from the Owner. Any interruption of normal service shall be performed during an overtime period to be scheduled with the Owner. Costs for overtime work shall be included in the Bid.

1.6 REQUIREMENTS

- A. Installation Instructions: Obtain manufacturer's printed installation instructions to aid in properly executing work on major pieces of equipment. Install equipment in accordance with manufacturer's recommendations.
- B. Objectionable Noise, Fumes and Vibration:
 - 1. Mechanical and electrical equipment shall operate without creating objectionable noise, fumes, or vibration, as determined by the Architect.
 - 2. If such objectionable noise, fumes, or vibration is produced and transmitted to occupied portions of building by apparatus, piping, ducts, or any other part of mechanical and electrical work, make necessary changes and additions, as approved, without extra cost to Owner.
- C. Equipment Design and Installation:
 - 1. Uniformity: Unless otherwise specified, equipment or material of same type or classification, used for same purposes, shall be product of same manufacturer.
 - 2. Design: Equipment and accessories not specifically described or identified by manufacturer's catalog number shall be designed in conformity with ASME, IEEE, or other applicable technical standards, suitable for maximum working pressure, and with neat and finished appearance.
 - 3. Installation: Erect equipment aligned, level and adjusted for satisfactory operation. Install so that connecting and disconnecting of piping and accessories can be made readily, and so that parts are easily accessible for inspection, operation, maintenance and repair. Minor deviations from indicated arrangements may be made, as approved.
- D. Hanging of Equipment, Ductwork and Piping:
 - 1. Support equipment, ductwork and piping from the top chord of bar joists at the "Panel Points" or from the flange of beams. Piping 2-inch (50 mm) nominal and smaller may be supported from the bottom chord of the bar joists at the "Panel Points".
- E. Protection of Equipment and Materials: Responsibility for care and protection of materials and mechanical work rests with the Contractor until the entire project has been completed, tested, and the project is accepted by the Owner.
- F. Ceiling Mounting: Where ceiling mounting is indicated or specified, use suspended platform or strap hangers, bracket or shelf, whichever is most suitable for equipment and its location. Construct of structural steel members, steel plates, or rods, as required; brace and fasten to building structure or to inserts as approved, or as detailed.

1.7 ACCESS PANELS

- A. Installation of access panels shall be in accordance with manufacturer's literature for anti-ligature access panels.
- B. Access panels shall be equal to Whitehall Manufacturing model #WH2805-18.
- C. Provide access panels in building construction where required for access to duct access doors or other components such as valves, air vents, actuators, fire dampers, volume dampers, motorized dampers in ductwork, duct smoke detectors, and other related items.

1.8 ELECTRIC WORK

- A. Provide motors, pilot lights, controllers, limit switches, and other related items for equipment provided under Division 23.
- B. Except as noted, required line switches, fused switches, and other related items and necessary wiring to properly connect equipment to motors and switches shall be furnished and installed under Division 26, Electric.
- C. Provide complete wiring system for automatic temperature controls as specified under Section Division 23 Section "Instrumentation and Controls for Mechanical Systems."
- D. Wiring shall conform to the requirements of the National Electrical Code.

1.9 FIRESTOPPING

- A. Firestopping for penetrations of ductwork, piping and equipment through fire rated and smoke rated building assemblies, including but not limited to partitions, walls, floors, ceilings, and roofs, shall be furnished and installed under this Section.
- B. Selection of firestopping materials and installation of firestopping materials shall be in accordance with Division 07 Section "Through Penetration Firestop Systems." Coordinate with other trades for a consistent installation.
- C. Refer to Architectural Drawings for locations of fire rated building assemblies.

1.10 SUBMITTALS

- A. After award of Contract and before installation, submit for approval Shop Drawings, bulletins, Product Data, Samples, and other related items.
- B. Submit Shop Drawings and Product Data as required in each Section. Submittal shall include physical data and performance data required to verify compliance with the Contract Documents.
- C. Architect/Engineer's review will not include the review, coordination, or verification of dimensions or quantities; these shall be the responsibility of the Contractor.

1.11 SUBSTITUTIONS

- A. Refer to Division 01.

1.12 COORDINATION

- A. Contractor shall coordinate closely with Owner to minimize negative impact on patients. Contractor shall be aware that the facility will be fully operational throughout the construction process and there will be times when there will be occupied patient floors both above and below the floor being renovated. Contractor shall be aware that patients are particularly sensitive to excessive vibration and noise, and shall work to minimize negative impact on patients at all times.

- B. Coordinate scheduling, submittals, and Work of the various Sections of Specifications to assure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- C. Verify that utility requirement characteristics of operating equipment are compatible with building utilities. Coordinate work of various Divisions having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- D. Coordinate space requirements and installation of mechanical and electrical work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with line of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- E. In finished areas, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
- F. Coordinate completion and clean-up of work of separate Sections in preparation for Substantial Completion.
- G. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

1.13 CLEANING

- A. Remove debris from site daily.
- B. Material and pieces of equipment shall be turned over to the Owner free of dust and dirt, both inside and out.
- C. At the completion of the Project, equipment shall have a clean, neat appearance of factory finish by cleaning or repainting as required.
- D. At the completion of the Project, surfaces exposed to view shall have a clean, neat appearance of finish free from smudges and scratches by cleaning or repainting as required.

1.14 STARTING SYSTEMS

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Notify Architect/Engineer 7 days prior to start-up of each item.
- C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or other conditions which may cause damage.
- D. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- E. Verify that wiring and support components for equipment are complete and tested.
- F. Execute start-up under supervision of responsible manufacturer's representative in accordance with manufacturer's instructions.

- G. When specified in individual Specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
- H. Submit a written report that equipment or system has been properly installed and is functioning correctly.

1.15 FACTORY START-UP AND START-UP REPORTS

- A. Provide factory start-up of mechanical equipment listed below. Factory start-up shall be performed by a factory authorized representative of the equipment manufacturer. When factory start-up is successfully completed for each piece of mechanical equipment listed below, submit a formal start-up report to the Architect for approval. Start-up report shall be formatted in accordance with equipment manufacturer's recommendations. Start-up report shall be typed, not hand written, and shall be submitted in a clean and legible form.
- B. Equipment requiring factory start-up
 1. Variable Refrigerant Volume units (Evaporators, condensing units, piping layouts and controls)
 2. Packaged Energy Recovery unit

1.16 ADJUSTMENTS AND OWNER'S INSTRUCTIONS

- A. After completion of the installation work called for in the Contract Documents, furnish necessary mechanics or engineers for the adjustment and operation of the systems, to the end that the systems are perfectly adjusted and turned over to the Owner in perfect working order. Further instruct the Owner's authorized representative in the care and operation of the installation, providing framed instruction charts, directions, and other related items.
- B. Instructors providing Owner training shall be experienced and familiar with the jobsite.

1.17 TESTING

- A. After the entire installation is completed and ready for operation, test the systems as outlined in Division 23 Section "Testing, Adjusting and Balancing for HVAC." These tests are supplementary to detailed tests specified herein or directed. The Owner will provide water and electric current for the test. Provide necessary labor, test pump, gauges, meters, other instruments, and materials. Perform tests in the presence of the Architect or his representative.
- B. Perform other tests specified in individual Sections of this Specification.

1.18 COMPLETION OF SYSTEMS

- A. The following mechanical systems shall not be complete until the following conditions are satisfied:
 1. Ductwork Systems:
 - a. Ductwork and related components and accessories shall be completely installed and insulated as specified.
 - b. Ductwork leakage testing shall be completed and leakage testing reports shall be

- submitted and approved.
 - c. Ductwork shall be balanced and a balancing report shall be submitted and approved.
 - 2. Piping Systems:
 - a. Piping, valves and accessories shall be completely installed, insulated and labeled as specified.
 - b. Piping pressure testing be completed and pressure testing reports shall be submitted and approved.
 - 3. Equipment:
 - a. Equipment, including but not limited to split system air conditioning equipment shall be completely installed.
 - b. Equipment start-up reports shall be completed, submitted and approved.
 - c. Equipment balancing shall be completed and the balancing report shall be submitted and approved.
 - 4. Automatic Temperature Controls (ATC):
 - a. ATC system shall be completely installed.
 - b. ATC system shall operate in an automatic mode for a minimum of 4 months during Owner occupancy without substantial deficiencies.

1.19 OPERATING AND MAINTENANCE MANUALS

- A. Refer to Division 01.

1.20 WARRANTY

- A. Provide guarantees and warranties for work under this Contract as indicated in the general requirements of the Contract.
- B. Provide manufacturers' standard warranties and guarantees for work by the mechanical trades. However, such warranties and guarantees shall be in addition to and not in lieu of other liabilities which the manufacturer and the Mechanical Contractor may have by law or by other provisions of the Contract Documents.
- C. Guarantee that elements of the systems provided under this Contract are of sufficient capacity to meet the specified performance requirements as set forth in these Specifications or as indicated on the Drawings.
- D. Upon receipt of notice from the Owner of failure of any part of the mechanical systems or equipment during the warranty period, the Mechanical Subcontractor shall replace the affected part or parts.
- E. Furnish a written guarantee covering the above requirements before submitting the application for final payment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 230500

SECTION 230513 – MOTORS, DRIVES, AND ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Common requirements for electric motors furnished on equipment specified in other Sections, including single phase and three phase electric motors.
- B. Shaft Grounding Rings
- C. Starters.
- D. Thermal Overload Protection.
- E. Belt Drives.

1.2 REFERENCES

- A. Division 01 for requirements for references and standards.
- B. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- C. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- D. NEMA MG 1 - Motors and Generators.
- E. NFPA 70 - National Electrical Code.
- F. UL 674 - UL Standard for Safety Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.
- G. UL 1836 - UL Standard for Safety for Electric Motors for Use in Class I, Division 2 and Class II, Division 2 Hazardous (Classified) Locations.

1.3 REGULATORY REQUIREMENTS

- A. Conform to UL Component Recognition for appropriate sizes.
- B. Conform to NFPA 70 and local energy code.

1.4 DELIVERY, STORAGE, AND PROTECTION

- A. Division 01 for transport, handle, store, and protect products.
- B. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 - PRODUCTS

2.1 MOTORS

- A. Acceptable Manufacturers:
 - 1. A.O. Smith.
 - 2. Baldor.
 - 3. Emerson Motor Technologies.
 - 4. General Electric.
 - 5. Greenheck Fan Corporation.
 - 6. Marathon Electric.
 - 7. Siemens.
 - 8. Teco-Westinghouse.
 - 9. Toshiba.
 - 10. U.S. Motors (division of Emerson Motor Technologies).

- B. General Construction and Requirements:
 - 1. Motors Less Than 250 Watts, for Intermittent Service: Equipment manufacturer's standard and need not conform to these specifications.
 - 2. Motors shall have integral thermal overload protection.
 - 3. Single Phase Motors for general applications: PSC (permanent split capacitor) where available.
 - 4. Single Phase Motors for fans:
 - a. EC (electronically commutated) where available.
 - b. PSC (permanent split capacitor) where available, if EC is not available.
 - 5. Open drip-proof type except where specifically noted otherwise.
 - 6. Design for continuous operation in 40 degrees C environment.
 - 7. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 - 8. Explosion-Proof Motors: UL approved for hazard classification.
 - 9. Visible Nameplate: Indicating manufacturer's name and model number, motor horsepower, RPM, frame size, voltage, phase, cycles, full load amps, insulation system class, service factor, maximum ambient temperature, temperature rise at rated horsepower, minimum efficiency.

- C. Inverter Duty: Motors for use with variable frequency drives shall be rated for A_{inverter duty}®, with winding insulation rated for 1600 volts and Class H (180°C) temperature rating.

- D. Single-Phase Power for Fans - Electronically-Commutated (EC) Motors - Also Known As Brush-Free DC (BFDC) Motors:
 - 1. Drive: Direct-drive only, not for use with belt drive.
 - 2. Power Supply: Internal motor circuitry shall convert AC power supplied to DC power to operate the motor.
 - 3. Turndown: Speed-controllable down to 20% of full speed (80% turndown).
 - 4. Speed Control: Integral potentiometer with screwdriver setting, remote potentiometer dial with 24 VDC transformer to generate a 0-10 VDC signal, or integral circuitry to accept a 0-10 VDC signal from the building control system, as indicated and specified.
 - 5. Efficiency: Minimum of 85% efficient at all speeds.
 - 6. Soft-start type, capable of reliable start at any speed setting.
 - 7. Enclosure: Open drip-proof.
 - 8. Bearings: Permanently lubricated heavy duty ball bearings.

9. Overload Protection:
 - a. Automatic Speed Control: In the event of overheating or overloading, the motor electronics slow the motor to operate within its acceptable range.
 - b. Thermal Overload: Internally fused, one-shot type as a last resort to prevent fires.
 - c. Locked Rotor: If the motor sees a locked rotor condition, it will automatically shut itself down, then try to restart 3 times. After the 3rd try, the motor will not attempt to restart until the power is cycled.

- E. Single Phase Power - Permanent-split Capacitor Motors:
 1. Starting Torque: Exceeding one fourth of full load torque.
 2. Starting Current: Up to six times full load current.
 3. Multiple Speed: Through tapped windings.
 4. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

- F. Single Phase Power - Capacitor Start Motors:
 1. Starting Torque: Three times full load torque.
 2. Starting Current: Less than five times full load current.
 3. Pull-up Torque: Up to 350 percent of full load torque.
 4. Breakdown Torque: Approximately 250 percent of full load torque.
 5. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
 6. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated bearings.
 7. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

- G. Single Phase Power - Split Phase Motors:
 1. Starting Torque: Less than 150 percent of full load torque.
 2. Starting Current: Up to seven times full load current.
 3. Breakdown Torque: Approximately 200 percent of full load torque.
 4. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
 5. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

- H. Three Phase Power - Squirrel-cage Motors:
 1. Starting Torque: Between 1 and 1-1/2 times full load torque.
 2. Starting Current: Six times full load current.
 3. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
 4. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B energy-efficient motors.
 5. Insulation System: NEMA Class B or better.
 6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
 7. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 200,000

hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

8. Sound Power Levels: To NEMA MG 1.
9. Part Winding Start Above 254T Frame Size: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.
10. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.
11. Nominal Efficiency: To NEMA MG 1, energy efficient for motor sizes 10 and larger.

2.2 SHAFT GROUNDING RINGS

- A. Manufacturers:
 1. Electro Static Technology Inc. - Aegis SGR product line.
 2. Inpro/Seal, a division of Waukesha Bearings Corporation - CDR product line.
- B. Provide shaft grounding rings (SGRs) on 3-phase motors 5 hp (3.7 kW) or larger which are intended to be used with variable-frequency drives (VFDs). The SGRs may be furnished by the motor manufacturer as an integral part of the motor, furnished factory-installed by the equipment manufacturer, or furnished for field installation by the equipment installer.
- C. Description: Circumferential micro-fiber ring with metal frame, designed to conduct VFD-induced bearing currents from the motor shaft to ground. Provides protection recommended in NEMA MG 1. Provide with mounting kit including bolts and bracket, or conductive epoxy to adhere to motor casing, to ensure ground connection from the SGR to the motor frame.

2.3 Provide SGRs on at least one end of the motor. On motors above 100 hp (74.5 kW), provide a bearing insulation kit on the end of the motor without an SGR.

2.4 STARTERS AND OVERLOADS

- A. Acceptable Manufacturers:
 1. Siemens.
 2. Allen-Bradley (division of Rockwell Automation).
 3. Cerus Industrial, Inc.
 4. Cutler Hammer (division of Eaton Corporation).
 5. General Electric.
 6. Square D (division of Schneider Electric).
- B. Motor starters shall be furnished for motors provided under this Section of these specifications. Each 3 phase motor starter shall have a 3-pole type, three element overload device and shall have "ON-AUTO-OFF" switch in cover plate. They shall be general purpose NEMA rated for connected H.P. (definite purpose starters not acceptable) and shall have control power with fused transformers as required. Coordinate control voltage with Controls Contractor. Provide auxiliary contacts where required for interlocking of electrical equipment. Provide two-speed motor starters where indicated.
 1. Single phase motors shall have one of the following factory wired methods of motor protection:
 - a. Integral thermal overload protection in motor and cord with plug and receptacle in unit casing.

- b. Integral thermal overload protection in motor and disconnecting switch mounted in or on casing as specified with equipment.
 - c. Switch with thermal overload protection for unprotected motors with switch serving as disconnect device.
- C. Thermal overload devices shall be sized for motor nameplate full load amps or field measured amp draw, whichever is less. Replace elements as required by field measurements.
- D. For starters associated with equipment that is required to be shut down upon a fire alarm condition, provide input contacts within the starter enclosure to interface with the building's fire alarm system. Upon receipt of a signal from the building's fire alarm system, power to load side of the starter shall be turned off. Circuitry shall be provided to ensure that power is off whether the starter is in the "AUTO", "HAND" or "BYPASS" mode. If this feature is not available from the starter manufacturer, provide a contactor on the line side of the starter to accomplish the same function. The contactor shall meet the requirements of division 16.
- E. At Contractor's option, Cerus Industrial "BAS" building automation HVAC starters may be provided. Features of starters/contactors, disconnects, and temperature controls may be combined in a single package using these starters. Coordination with Automatic Temperature Controls supplier and installer is recommended to reduce total project costs. Features include:
- 1. Multi-tap control power transformer (CPT) for universal control voltage.
 - 2. Motor circuit protector disconnect (MCP) with high interrupt rating and lockable operator handle.
 - 3. Contactors rated as high as 2.5 million electrical operations and 25 million mechanical operations.
 - 4. Anti-cycling feature.
 - 5. Solid-state electronic overloads with wide adjustment range and highly accurate digital motor protection, including protection for phase loss, phase unbalance, stall and locked rotor conditions. Class 1-30.
 - 6. Digital keypad, featuring an H-O-A (Hand, Off , Auto) panel with large, clearly labeled push buttons including a front panel reset function and high-intensity LED indicators for settings.
 - 7. Damper and valve actuator control, to open the actuator before starting the fan or pump motor.
 - 8. Permissive auto control to disable auto inputs. Commonly used with a high pressure limit switch.
 - 9. Universal control inputs, including auto dry input, and wet input for voltages from 20 to 138 VAC or VDC.
 - 10. Power failure reset.
 - 11. Fireman's override.
 - 12. NEMA 1 enclosure with prepunched knockouts. NEMA 3R, 4, 4X, and 12 as required.
 - 13. BACnet embedded communications option available.
 - 14. UL Listed assembly.
 - 15. 5-year warranty.

2.5 V-BELT DRIVES

- A. Provide self-aligning roller-bearings mounted in sealed housings with grease fittings and grease overflow valves. Fan wheels and shafts shall be designed for critical speed at least 20% higher than the maximum fan speed. The assembled fan shall be statically and dynamically balanced

at the factory. Bearings shall be certified to have an average life per AFBMA of not less than 200,000 hours.

- B. Provide adjustable belt drives for motors. Belts and pulleys shall be designed for a minimum 1.5 safety factor. The base shall be constructed to allow adjustment of belt tension without having to loosen motor hold-down bolts.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Division 01 for Quality Requirements”: Manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and direction of rotation, and ensure agreement with nameplate.
- D. Install guards in accordance with Codes and OSHA requirements.

END OF SECTION 230513

SECTION 230517 – SLEEVES AND ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe Sleeves.
- B. Watertight Pipe Sleeves.
- C. Escutcheons.
- D. Floor Plates.

1.2 RELATED SECTIONS

- A. Division 23 Section “Common Work Results for HVAC” – Firestopping.
- B. Division 23 Section “Hydronic Piping.”

1.3 REFERENCES

- A. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
- B. ASTM C1107 - 11 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
- C. ASTM D1785 - Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide sleeves for piping penetrations of building construction such as interior partitions, interior and exterior walls, floors, and roofs.
- B. Provide watertight pipe sleeves for piping penetrations of basement and foundation walls below grade, on-grade floor slabs, floors in potentially wet locations, roof slabs, and at other locations as specified or indicated on the Drawings.
- C. Provide escutcheons and floor plates at piping penetrations of building construction.
- D. Coordinate

1.5 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures.”
- B. Product Data: For each type of product indicated.
- C. Manufacturer's Installation Instructions: Indicate special procedures, and external controls.

1.6 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01 Section "Project Record Documents."
- B. Record actual locations of watertight sleeve-seal fittings.

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01 Section "Operation and Maintenance Data."

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years' experience.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01.
- B. Protect materials from exposure by leaving factory coverings and packaging in place until installation.

1.10 WARRANTY

- A. Provide warranty under provisions of Division 01 Section "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PIPE SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A53, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A53, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. PVC-Pipe Sleeves: ASTM D1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- F. Molded-Polyethylene (PE) or molded-polypropylene (PP) Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 WATERTIGHT PIPE SLEEVES

A. Manufacturers:

1. Pipeline Seal and Insulator, Inc., a division of EnPro Industries, Inc. - Thunderline Link-Seal product line. [<http://www.linkseal.com/>]
2. Advance Products & Systems, Inc. – Innerlynx product line. [<http://apsonline.com/innerlynx.html>]
3. Calpico, Inc. – Pipe Linx product line. [<http://www.calpicoinc.com/html/brochures.php>]
4. Metraflex Company – MetraSeal product line. [http://www.metraflex.com/wall_pen.php]
5. Proco Products, Inc. – Pen-Seal product line. [<http://www.procoproducts.com/pipepenseal.html>]

B. Sealing Element Assembly: Modular mechanical seal, consisting of rubber links shaped to continuously fill the annular space between the pipe and the wall opening. Compression hardware shall consist of hex-head nuts and bolts. Pressure plates at each bolt shall spread the tensional forces evenly from the hardware to the links. Each link shall have permanent identification of the size and manufacturer's name molded into the pressure plate and sealing element.

1. Links: Rubber of material suitable for the application. Coloration shall be throughout rubber for positive field inspection. Select material for the anticipated exposure to chemicals and light, and the anticipated temperature range. Sustained operation near temperature limits may affect life expectancy; select accordingly.
 - a. Standard (black) EPDM rubber shall be resistant to most inorganic acids and alkalis, and some organic chemicals (including acetone, alcohol, and ketones). Suitable for use in water, direct ground burial in uncontaminated soils, and atmospheric conditions. Temperature range: -40 to 250 degrees F (-40 to 121 degrees C).
 - b. Low-durometer (blue) EPDM rubber shall be suitable for thinwall and fragile piping and tubing which may not withstand the compressing forces generated by a standard seal. Temperature range: -40 to 250 degrees F (-40 to 121 degrees C).
 - c. Nitrile (green) rubber shall be resistant to oils, fuel, and many solvents (including gasoline, motor oil, kerosene, methane, jet fuel, hydraulic fluid, and water). While resistant to normal atmospheric conditions, Nitrile is not U.V. resistant, therefore not suitable for locations exposed to direct or indirect sunlight. Temperature range: -40 to 210 degrees F (-40 to 99 degrees C).
 - d. Silicone (grey) rubber shall be suitable for temperature extremes, and shall be one-hour FM (Factory Mutual) approved. Temperature range: -67 to 400 degrees F (-55 to 204 degrees C).
2. Pressure Plates: Plates used with EPDM and nitrile rubber links shall be composite, molded of glass reinforced nylon. Plates used with silicone rubber links shall be steel, with zinc-dichromate plating for corrosion resistance.
3. Hardware: Mild steel with a 2-part Zinc Dichromate coating per ASTM B-633 and Organic Coating, tested in accordance with ASTM B-117 to pass a 1,500-hour salt spray test. 60,000 psi (413 MPa) minimum tensile strength.

C. Sleeve: Provide smooth, core-drilled hole in concrete construction, or a metal or plastic pipe sleeve.

1. Metal Sleeves: Cast iron pipe when installed below grade or in locations which can be

anticipated to often be wet or damp. Galvanized steel schedule 40 pipe when installed in normally-dry locations.

2. Plastic Pipe Sleeves: Schedule 40 PVC, ABS, or AquaTherm polypropylene pipe.
3. Molded Pipe Sleeves for Casting Into Concrete: High density polyethylene (HDPE) or polyvinyl chloride (PVC) plastic, with end caps and reinforcing ribs, and integral hollow, molded water-stop ring 4 inch (100 mm) larger than the outside diameter of the sleeve itself.

2.3 ESCUTCHEONS

- A. Material: Brass at floors and in potentially damp or wet locations. Brass or steel in other locations.
- B. Finish: Except as indicated below, polished chrome plated in exposed locations, prime painted steel or rough brass in mechanical rooms and similar spaces.
- C. One-Piece, Cast-Brass Type: With finish and setscrew fastener.
- D. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- E. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- F. Split-Casting Brass Type: With concealed hinge and setscrew.
- G. Split-Plate, Stamped-Steel Type: With chrome-plated finish, hinge, and spring-clip fasteners.

2.4 FLOOR PLATES

- A. Material: Brass in exposed locations. Brass or cast iron in other locations including mechanical equipment spaces.
- B. Finish: Except as indicated below, polished chrome plated in exposed locations, prime painted steel or rough brass in mechanical rooms and similar spaces.
- C. One-Piece Floor Plates: Cast-iron flange.
- D. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as the slabs and walls are constructed.

- D. Size sleeves to allow firestopping.
- E. Size holes and sleeves to allow the required clear annular space for insulation, and a minimum of 1/4 in. (6.4 mm) clear outside the pipe and insulation for movement due to and expansion and contraction.
- F. Watertight Pipe Sleeves: Provide watertight pipe sleeve systems in penetrations of exterior concrete walls and slabs-on-grade at service piping entries into building, and at other locations as specified or indicated on the Drawings.
 - 1. Provide smooth, core-drilled hole in concrete construction, or a metal or plastic pipe sleeve.
 - 2. For core-drilled holes, additional sleeves aren't required. Grind and grout surfaces of holes smooth as required for a tight seal.
 - 3. Size holes and sleeves to allow the required clear annular space for the sealing system.
 - 4. Select type, size, and number of sealing link elements required for piping material and size and for sleeve ID or hole size.
 - 5. Position piping in center of sleeve. Center piping in penetration, assemble watertight 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.
- G. Cut sleeves flush with both surfaces, except at floors.
- H. Extend sleeves through floors as follows: In locations not otherwise indicated, 2 inch (50 mm) above finished floor level. In normally-dry locations such as finished office spaces under fintube and baseboard radiation, 1 inch (25 mm) above finished floor level. Finished floor level includes the thickness of floor finish materials such as carpet and tile. Caulk sleeves full depth and provide floor plate.
- I. Fasten sleeves permanently in place.
- J. Using grout, seal the space outside of sleeves in concrete slabs and walls which do not have watertight sleeve system.
- K. Provide escutcheons for piping penetrations of walls, ceilings, and finished floors.
- L. Provide floor plates for piping penetrations of equipment-room floors.
- M. Escutcheons and floor plates on bare piping shall be one-piece type where possible. Escutcheons and floor plates on insulated piping and on existing piping shall be split, hinged type.
- N. Size escutcheons and floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

END OF SECTION 230517

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SECTION 230529 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe hangers and supports.

1.2 RELATED SECTIONS

- A. Division 23 Section “HVAC Piping Insulation.”
- B. Division 23 Section “Hydronic Piping.”

1.3 REFERENCES

- A. ASME B31.9 - Building Services Piping.
- B. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- C. ASTM A653 G90 SS Gr. 33 - Specification for Steel Sheet, Zinc Coated (Galvanized) by the Hot Dipped Process.
- D. ASTM B633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- E. ASTM C531 - Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Mortars, Grouts, Monolithic Surfaces, and Polymer Concretes.
- F. ASTM C642 - Test Method for Specific Gravity, Absorption, and Voids in Hardened Concrete.
- G. ASTM C672 - Test Methods for Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals.
- H. ASTM D395 - Standard Test Methods for Rubber Property - Compression Set.
- I. ASTM D412 - Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
- J. ASTM D573 - Test Method for Rubber - Deterioration in an Air Oven.
- K. ASTM D746 - Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
- L. ASTM D2240 - Test Method for Rubber Property - Durometer Hardness.
- M. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- N. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
- O. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
- P. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

Q. NFPA 70 - National Electrical Code

1.4 SUBMITTALS

- A. Submit under provisions of Division 01 Section "Submittal Procedures".
- B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
- C. Product Data: Provide manufacturers catalog data including load capacity.
- D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- E. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years' experience.

1.6 REGULATORY REQUIREMENTS

- A. Conform to applicable Codes for support of piping.
- B. Supports for Electrical: In conformance with NFPA 70 and Division 26 of the Specifications.

PART 2 - PRODUCTS

2.1 HANGERS, SUPPORTS, & PIPE CLAMPS

- A. Approved Manufacturers (first manufacturer is basis of design):
 - 1. Strut Hangers:
 - a. Unistrut (division of Tyco).
 - b. Anvil International.
 - c. Cooper B-Line.
 - d. Hydra-Zorb Company.
 - e. Thomas & Betts - Superstrut line.
 - f. Tolco (division of Cooper B-Line).
 - 2. Adjustable Swivel Band Hangers:
 - a. Carpenter & Paterson.
 - b. Anvil International.
 - c. Cooper B-Line.
 - d. Tolco (division of Cooper B-Line).
 - 3. Clevis Hangers:
 - a. Cooper B-Line.
 - b. Anvil International.
 - c. Carpenter & Paterson.
 - d. Tolco (division of Cooper B-Line).
 - 4. J-Hangers:
 - a. Cooper B-Line.

- b. Carpenter & Paterson.
 - c. Thomas & Betts - Superstrut line.
 - d. Tolco (division of Cooper B-Line).
 - e. Unistrut (division of Tyco).
5. Roof Support Blocks/Non-Penetrating Roof-Mounted Pipe & Duct Support System:
- a. Cooper B-Line - Dura-Blok line.
 - b. Miro Industries.
 - c. Unistrut (division of Tyco) - Unipier line.
 - d. No substitutions.
6. Cushion Clamps:
- a. Hydra-Zorb Company.
 - b. Cooper B-Line.
 - c. Thomas & Betts - Superstrut line.
 - d. Tolco (division of Cooper B-Line).
 - e. Unistrut (division of Tyco).
7. Insulated Pipe Couplings:
- a. Cooper B-Line - Armafix line.
 - b. Klo-Shure Corporation.
8. No substitutions.
- B. Horizontal Piping Supports: Provide struts for trapeze hangers for single or multiple pipes. Where individual piping runs are hung with individual hangers, adjustable swivel band hangers, clevis hangers, or j-hangers may be used.
- C. Strut hangers shall be standard 1-5/8 inches x 1-5/8 inches (41x41 mm) size.
- D. Hangers, clamps, and supports located outdoors or otherwise exposed to weather, or in wet or washdown areas, shall be hot-dipped galvanized steel or 300-series stainless steel. Struts may be extruded aluminum. Threaded rods, nuts, and washers may have standard galvanizing if hot-dipped galvanized is not available.
- 1. Hot-dipped galvanized steel shall have a nominal zinc coating of 2.6 mil (0.066 mm) thickness and 1.5 oz./sq.ft (458 g/m²) coating weight.
 - 2. In lieu of galvanizing, strut systems and their accessories may have Unistrut Perma-Green III electrodeposited thermoset acrylic coating, or be epoxy-coated equal to B-Line's Dura-Green or Dura-Copper coatings.
 - 3. Lesser coatings for struts and clamps, such as pre-galvanizing (0.75 mil (0.019 mm) thickness), electroplated zinc (0.2 to 0.5 mil (0.005 to 0.013 mm) thickness), and yellow zinc dichromate coating, are not acceptable in these locations.
- E. Pipe hanger rods and nuts shall be plated to match the hangers. Nuts shall be self-locking type, or provide double nuts tightened to lock together. Rods shall be threaded one end, or continuous threaded. Provide washers at each nut.
- F. Cushion Clamps for Un-insulated Lines: Plastic cushion shall be Dupont Hytel plastic, 5555HS plastic elastomer, warranted from -40 to 275 degrees F (-40 to 135 degrees C).
- G. Copper-plated hangers are plated for identification only. Traditional thin copper plating on steel substrate does not provide adequate protection from galvanic corrosion due to contact between dissimilar metals.
- 1. Where copper-plated supports are specified for use with copper piping, either copper plating or a copper-colored finish such as Cooper B-Line's Dura-Copper epoxy coating is

- acceptable. This is for identification, and does not protect dissimilar metals.
2. Where copper piping is used with steel hangers and supports, provide protection from galvanic corrosion such as thick plastic or vinyl factory coating, or plastic-lined cushion clamps.
- H. For Insulated Lines Clamped to Strut: Insulated pipe coupling insert with the same thickness as the insulation. Protects insulation from crushing, and provides continuous insulation and vapor barrier thru the hanger or clamp. Klo-Shure product provides plastic pipe support and rigid outer band, for field insulation into the coupling. Armafix product provides insulation with rigid outer band, for field insulation glued to the ends of the insert.

2.2 PIPE SUPPORTS

- A. Low Pressure Steam and Hydronic Piping:
1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69 and MSS SP89.
 2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch (13 to 38 mm): Malleable iron, adjustable swivel, split ring.
 3. Hangers for Cold Pipe Sizes 2 inches (50 mm) and Over: Carbon steel, adjustable, clevis.
 4. Hangers for Hot Pipe Sizes 2 to 4 inches (50 to 100 mm): Carbon steel, adjustable, clevis.
 5. Hangers for Hot Pipe Sizes 5 inches (125 mm) and Over: Adjustable steel yoke, cast iron roll, double hanger.
 6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches (150 mm) and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
 8. Wall Support for Pipe Sizes to 3 inches (76 mm): Cast iron hook.
 9. Wall Support for Cold Pipe Sizes 4 inches (100 mm) and Over: Welded steel bracket and wrought steel clamp.
 10. Wall Support for Hot Pipe Sizes 4 inches (100 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
 11. Vertical Support: Steel riser clamp.
 12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 13. Floor Support for Hot Pipe Sizes to 4 inches (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 14. Floor Support for Hot Pipe Sizes 5 inches (125 mm) and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
 15. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- B. Refrigerant Piping:
1. Conform to ASME B31.5, ASTM F708, MSS SP58, MSS SP69 and MSS SP89.
 2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch (13 to 38 mm): Malleable iron, adjustable swivel, split ring.
 3. Hangers for Pipe Sizes 2 inches (50 mm) and Over: Carbon steel, adjustable, clevis.
 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 5. Wall Support for Pipe Sizes to 3 inches (75 mm): Cast iron hook.
 6. Wall Support for Pipe Sizes 4 inches (100 mm) and Over: Welded steel bracket and wrought steel clamp.
 7. Vertical Support: Steel riser clamp.
 8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.2 PIPE HANGERS AND SUPPORTS

- A. Support horizontal piping as scheduled.
- B. Install hangers to provide minimum 1/2 inch (13 mm) space between finished covering and adjacent work.
- C. Place hangers within 12 inches (300 mm) of each horizontal elbow.
- D. Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment.
- E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet (1.5 m) maximum spacing between hangers.
- F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Provide copper plated hangers and supports for copper piping.
- J. Design hangers for pipe movement without disengagement of supported pipe.
- K. Prime coat exposed steel hangers and supports. Refer to Division 09 Section "Painting". Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- L. Do not support pipes from other pipes or equipment.
- M. Size pipe hangers to accommodate continuous piping insulation.

3.3 SUPPORTING OTHER TRADES

- A. Supports furnished under Division 23 of the Specifications may also be used to support piping furnished under Division 22 "Plumbing" and conduits furnished under Division 26 "Electrical" if this Subcontractor is willing to allow this. Supports shared with other trades shall be designed to accommodate the weight, expansion/contraction, vibration, and other requirements of the other trades' items without detriment to the function, accessibility, and serviceability of the HVAC items or those of the other trades. Provide flexible sections of piping and conduit as required to allow each trade's items to expand and contract along with the other trades, and to absorb vibration caused by the other trades.

- B. Electrical lighting fixtures and equipment, and architectural items such as ceilings, may not be supported from supports furnished under this Section.
- C. Prevent contact between components of other trades, such as architectural suspended ceiling support wires, and HVAC supports which may transmit vibration to the occupied space.

3.4 SCHEDULES

PIPE SIZE		HANGER ROD MAX. HANGER SPACING		DIAMETER	
Inches	(mm)	Feet	(m)	Inches	(mm)
Steel and Copper Piping					
1/2 to 1-1/4	12 to 32	6.5	2	3/8	9
1-1/2 to 2	38 to 50	10	3	3/8	9
2-1/2 to 3	62 to 75	10	3	1/2	13
4 to 6	100 to 150	10	3	5/8	15
8 to 12	200 to 300	14	4.25	7/8	22
14 and Over	350 and Over	20	6	1	25
PVC (All Sizes)		6	1.8	3/8	9

END OF SECTION 230529

SECTION 230553 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Labels.
- D. Stencils.
- E. Pipe Markers.

1.2 RELATED SECTIONS

- A. Division 09 Section “Painting”: Identification painting.

1.3 REFERENCES

- A. Division 01 Section “References”: Requirements for references and standards.
- B. ASME A13.1 - Scheme for the Identification of Piping Systems (2007 edition or newer).
- C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- D. NFPA 99 - Standard for Health Care Facilities.

1.4 SUBMITTALS

- A. Division 01 Section “Submittal Procedures.”
- B. Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Product Data: Provide manufacturers catalog literature for each product required.
- E. Samples: Submit 2 tags, 1-1/2 inches (38 mm) in size.
- F. Samples: Submit 2 labels, 1.9 x 0.75 inches (48 x 19 mm) in size.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under Division 01 Section “Closeout Procedures.”
- B. Record actual locations of tagged valves; include valve tag numbers.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01 Section "Operation and Maintenance Data."
- B. Include valve tag chart.

1.7 REGULATORY REQUIREMENTS

- A. Conform to NFPA 99 requirements for labeling and identification of medical gas piping systems and accessories.

PART 2 - PRODUCTS

2.1 NAMEPLATES

- A. Manufacturers:
 - 1. Seton Identification Products.
 - 2. E.R. Perry Signs & Engraving.
 - 3. Brimar Industries, Inc., PipeMarker division.
 - 4. No substitutions.
- B. Plastic Nameplates: Laminated 3-layer plastic with beveled edges and engraved letters on contrasting background color, 1/16 inch (1.58 mm) thick. Letters shall be black on light backgrounds, or white on dark backgrounds, as applicable. Service temperature range -40 to 175 degrees F (-40 to 79 degrees C); minimum application temperature for adhesive 50 degrees F (10 degrees C). Suitable for average outdoor lifespan of at least 2-3 years.
- C. Aluminum Nameplates: For higher temperature applications, and for outdoor applications when manufacturer does not recommend their plastic nameplates for use outdoors, provide aluminum nameplates, with integral anodized or painted surface color coating and natural aluminum engraved letters, 1/32-inch (0.78 mm) thick. Service temperature range -40 to 350 degrees F (-40 to 177 degrees C); minimum application temperature for adhesive 50 degrees F (10 degrees C). Suitable for average outdoor lifespan of at least 2-3 years.
- D. Colors: Select background color as appropriate for the application. Color for general applications shall be white (except that aluminum nameplate standard color shall be black). Color for general warnings shall be red or yellow. Colors for fluid services shall comply with ASME A13.1-2007. Comply with ASME/ANSI standards and other regulations as applicable.
- E. Provide with factory adhesive, and with side holes for fastener attachment as applicable. Mechanical fasteners are required for applications which are outdoors or otherwise exposed to weather or sunlight, or in moist areas such as kitchens and locker rooms, or on cooled surfaces subject to condensation, or on surfaces with operating temperatures above 150 degrees F (65 degrees C). Where nameplate is on an irregular surface and cannot make complete contact, provide mechanical fasteners or ties in addition to adhesive.

2.2 TAGS

- A. Plastic Tags:
 - 1. Manufacturers:
 - a. Seton Identification Products.

- b. E.R. Perry Signs & Engraving.
 - c. Brimar Industries, Inc., PipeMarker division.
 - d. No substitutions.
2. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inches (38 mm) diameter.

B. Metal Tags:

1. Manufacturers:
 - a. Seton Identification Products.
 - b. Brady Worldwide, Inc.
 - c. Brimar Industries, Inc., PipeMarker division.
 - d. No substitutions.
2. Brass with stamped letters; tag size minimum 1-1/2 inches (38 mm) diameter with smooth edges.

C. Information Tags:

1. Manufacturer: Seton Identification Products.
2. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches (83 x 143 mm) with grommet and self-locking nylon ties.

D. Tag Chains and Hooks: Brass or stainless steel compatible with tag material for general applications. Brass where in contact with copper piping or other copper-alloy materials.

E. Tag Chart: Typewritten letter size list in anodized aluminum frame with plexiglass cover.

2.3 LABELS

A. Manufacturer: Seton Identification Products.

B. Description: Polyester, size 1.9 x 0.75 inches (48 x 19 mm), adhesive backed with printed identification.

2.4 STENCILS

A. Manufacturers:

1. Seton Identification Products.
2. Brimar Industries, Inc., PipeMarker division.

B. Stencils: With clean cut symbols and letters of following size:

1. Up to 2 inch (51 mm) Outside Diameter of Insulation or Pipe: 1/2 inch (13 mm) high letters.
2. 2-1/2 to 6 inches (64-150 mm) Outside Diameter of Insulation or Pipe: 1 inch (25 mm) high letters.
3. Over 6 inches (150 mm) Outside Diameter of Insulation or Pipe: 1-3/4 inches (44 mm) high letters.
4. Ductwork and Equipment: 1-3/4 inches (44 mm) high letters.

C. Stencil Paint: As specified in Division 09 Section "Painting", semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

2.5 PIPE MARKERS

- A. Color and Lettering: Conform to ASME A13.1.
- B. Plastic Pipe Markers:
 - 1. Manufacturers:
 - a. Seton Identification Products.
 - b. Brady Worldwide, Inc.
 - c. Brimar Industries, Inc., PipeMarker division.
 - d. No substitutions.
 - 2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Division 09 Section "Painting" for stencil painting.

3.2 INSTALLATION

- A. Division 01 Section "Quality Requirements": Manufacturer's instructions.
- B. Install identifying devices after completion of coverings and painting.
- C. Install plastic or aluminum engraved nameplates with corrosion-resistant mechanical fasteners, or adhesive, as specified. In outdoor locations, where lifetime of nameplates is limited, fasteners shall be removable screws or bolts for ease of nameplate replacement.
- D. Install labels with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
- E. Install tags using corrosion resistant chain. Number tags consecutively by location.
- F. Apply stencil painting in accordance with Division 09 Section "Painting."
- G. Identify items of mechanical equipment such as ductless split systems with plastic nameplates.
- H. Identify control panels and major control components outside panels with plastic nameplates.
- I. Identify valves in main and branch piping with metal tags.
- J. Tag automatic controls, instruments, and relays. Key to control schematic.
- K. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch (20 mm) diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet (6 m) on straight runs including risers and drops, at each branch and riser take-off, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

- L. Identify ductwork with stenciled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- M. Identify duct access doors at fire dampers, smoke dampers, and smoke detectors with 1/2 inch (12.7 mm) lettering to indicate the fire protection device(s) within, in accordance with NFPA 90A.
- N. Secure valve tag chart on an easily accessible wall in the mechanical room or in a location as otherwise directed by the Owner.

3.3 COORDINATION WITH EXISTING EQUIPMENT

- A. Where an existing equipment identification system is involved, the new system shall be coordinated and compatible with the existing system and facilities standards.

END OF SECTION 230553

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SECTION 230593 – TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Testing, Adjustment, and Balancing of Air Systems.
- B. Testing, Adjustment, and Balancing of Hydronic Piping Systems.

1.2 RELATED SECTIONS

- A. Division 01 Section “Quality Requirements”: Testing laboratory services: Employment of testing agency and payment for services.

1.3 REFERENCES

- A. AABC - National Standards for Total System Balance.
- B. ADC - Test Code for Grilles, Registers, and Diffusers.
- C. ASHRAE 111 - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.
- D. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
- E. SMACNA - HVAC Systems Testing, Adjusting, and Balancing.

1.4 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers.
- C. NEBB: National Environmental Balancing Bureau.
- D. SMACNA: Sheet Metal and Air Conditioning Contractors’ National Association.
- E. TAB: Testing, Adjusting, and Balancing.

1.5 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures.”
- B. Submit name of TAB Agency for approval within 14 days after award of Contract.
- C. Design Review Reports:
 - 1. Review the Contract Documents, and indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

- D. Field Reports: Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/Engineer and for inclusion in operating and maintenance manuals.
- E. Provide reports in letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
- F. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty prior to commencing system balance.
- G. Test Reports: Indicate data on AABC National Standards for Total System Balance forms , forms prepared following ASHRAE 111, NEBB forms, or forms containing information indicated in Schedules.

1.6 QUALITY ASSURANCE

- A. Perform total system balance in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance, ASHRAE 111, or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.7 QUALIFICATIONS

- A. Agency: Company specializing in the testing, adjusting, and balancing of systems specified in this Section with minimum three years' experience
- B. Perform Work under supervision of a registered Professional Engineer experienced in performance of this Work and licensed in Maine.
- C. The approved Agency shall be in no way affiliated with the installing Subcontractor.

1.8 SEQUENCING

- A. Sequence work under the provisions of Division 01 Section "Summary."
- B. Sequence work to commence after completion of systems or portions of work, and schedule completion of work before Substantial Completion of Project.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 AGENCIES

- A. Tekon Technical Consultants, Rochester, NH. Contact: Charles Corlin, (603) 335-3080.
- B. Whitetail Air Balance LLC, Lisbon, ME. Contact: Jim Davis, (207) 577-9292.
- C. Air Solutions, Auburn, NH, Contact: Jeremy Reid, (603) 262-9292

- D. Thomas-Young Associates, Inc., Marion, MA. Tel. (508) 748-0204.
- E. Leonhardt Company Inc., Wellesley, MA. Tel. (781) 237-7200.
- F. Hood T.A.B. LLC, Andover, MA. Contact: Michael Hood, (978) 474-7595.
- G. NETB Associates LLC, East Kingston, NH. Contact: Frank Collamore, (978) 270-7547.
- H. H&S Associates, Rochester, NH. Contact: Harry Wiggin, 603-742-2456.
- I. Advantage Engineering, 19 Technology Way, Nashua, NH. Contact: Kevin LaPlante 603-731-3880
- J. No Substitutions.

3.2 EXAMINATION

- A. Verify that systems are complete and operating correctly in accordance with sequence of operations before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Duct systems are clean of debris.
 - 5. Fans are rotating correctly.
 - 6. Volume dampers are in place and open.
 - 7. Air coil fins are cleaned and combed.
 - 8. Access doors are closed and duct end caps are in place.
 - 9. Air outlets are installed and connected.
 - 10. Hydronic systems are flushed, filled, and vented.
 - 11. Pumps are rotating correctly.
 - 12. Proper strainer baskets are clean and in place.
 - 13. Service and balance valves are open.
- B. Submit field reports. Report to the responsible Subcontractors, defects and deficiencies noted during performance of services which prevent system balance. Submit list of locations where the Contractor needs to provide additional balancing devices.
- C. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.4 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.5 ADJUSTING

- A. Ensure recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings

3.6 AIR SYSTEM PROCEDURE

- A. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- B. Measure air quantities at air inlets and outlets.
- C. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- D. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- E. Provide system schematic (in floor-plan or line-diagram view) with outlets and inlets numbered with the reference numbers used in the TAB Agent's tabular data, and with required and actual air quantities recorded at each outlet or inlet.
 - 1. Indicate locations of duct traverses.
 - 2. Indicate locations of duct pressure sensors, airflow monitoring stations, and other devices which require measurements for control settings.
- F. Set pattern-control vanes and other devices in air inlets and outlets to provide the spread and throw patterns indicated, without objectionable noise or air motion to the occupants. Split the flow of linear slot diffusers in directions as required for good coverage. At completion, patterns shall be uniform and pleasing to the eye.

3.7 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing.

3.8 VERIFICATION OF DUCT LEAKAGE TESTING

- A. The TAB Agent shall witness the duct leakage tests performed under Division 23 Section "Metal Ducts." At a minimum, the first duct leakage test shall be witnessed and approved by the TAB Agent and the Engineer. At a minimum, subsequent duct leakage tests shall be witnessed and approved by the TAB Agent. The TAB Agent shall confirm proper testing procedures and shall give written approval to leakage tests. If deficiencies are discovered, the TAB Agent shall document these deficiencies to the Contractor and the Engineer. Once deficiencies are corrected, the TAB Agent shall witness follow-up leakage tests.

3.9 SCHEDULES

- A. Equipment:
1. VRV evaporators
 2. Air Inlets and Outlets
 3. Packaged Rooftop Energy Recovery Unit
 4. Glycol Hydronic System
 5. Hot Water Baseboard Radiation
- B. Report Forms:
1. Title Page:
 - a. Name of Testing, Adjusting, and Balancing Agency
 - b. Address of Testing, Adjusting, and Balancing Agency
 - c. Telephone number of Testing, Adjusting, and Balancing Agency
 - d. Project name
 - e. Project location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor
 - i. Project altitude
 - j. Report date
 2. Summary Comments:
 - a. Design versus final performance
 - b. Notable characteristics of system
 - c. Description of systems operation sequence
 - d. Summary of outdoor and exhaust flows to indicate amount of building pressurization
 - e. Nomenclature used throughout report
 - f. Test conditions
 3. Instrument List:
 - a. Instrument
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Range
 - f. Calibration date
 4. Electric Motors:
 - a. Manufacturer
 - b. Model/Frame
 - c. HP/BHP
 - d. Phase, voltage, amperage; nameplate, actual, no load

- e. RPM
- f. Service factor
- g. Starter size, rating, heater elements
- 5. Sheave Make/Size/BoreV-Belt Drive:
 - a. Identification/location
 - b. Required driven RPM
 - c. Driven sheave, diameter and RPM
 - d. Belt, size and quantity
 - e. Motor sheave diameter and RPM
 - f. Center to center distance, maximum, minimum, and actual
- 6. Pump Data:
 - a. Identification/number
 - b. Manufacturer
 - c. Size/model
 - d. Impeller
 - e. Service
 - f. Design flow rate, pressure drop, BHP
 - g. Actual flow rate, pressure drop, BHP
 - h. Discharge pressure
 - i. Suction pressure
 - j. Total operating head pressure
 - k. Shut off, discharge and suction pressures
 - l. Shut off, total head pressure
- 7. Heat Exchanger:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Model number
 - f. Serial number
 - g. Steam pressure, design and actual
 - h. Primary water entering temperature, design and actual
 - i. Primary water leaving temperature, design and actual
 - j. Primary water flow, design and actual
 - k. Primary water pressure drop, design and actual
 - l. Secondary water leaving temperature, design and actual
 - m. Secondary water leaving temperature, design and actual
 - n. Secondary water flow, design and actual
 - o. Secondary water pressure drop, design and actual
- 8. Cooling Coil Data:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Rows, and fins per inch
 - f. Air flow, design and actual
 - g. Entering air DB temperature, design and actual
 - h. Entering air WB temperature, design and actual
 - i. Leaving air DB temperature, design and actual
 - j. Leaving air WB temperature, design and actual
 - k. Water flow, design and actual

- l. Water pressure drop, design and actual
- m. Entering water temperature, design and actual
- n. Leaving water temperature, design and actual
- o. Refrigerant saturated suction temperature, design and actual
- p. Refrigerant superheat temperature
- q. Air pressure drop, design and actual
- 9. Heating Coil Data:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Rows, and fins per inch
 - f. Air flow, design and actual
 - g. Water flow, design and actual
 - h. Water pressure drop, design and actual
 - i. Entering water temperature, design and actual
 - j. Leaving water temperature, design and actual
 - k. Entering air temperature, design and actual
 - l. Leaving air temperature, design and actual
 - m. Air pressure drop, design and actual
- 10. Air Moving Equipment:
 - a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Arrangement/Class/Discharge
 - f. Air flow, specified and actual
 - g. Return air flow, specified and actual
 - h. Outside air flow, specified and actual
 - i. Total static pressure (total external), specified and actual
 - j. Inlet pressure
 - k. Discharge pressure
 - l. Component pressure drops
 - m. Sheave Make/Size/Bore
 - n. Number of Belts/Make/Size
 - o. Fan RPM
- 11. Return Air/Outside Air Data:
 - a. Identification/location
 - b. Design air flow
 - c. Actual air flow
 - d. Design return air flow
 - e. Actual return air flow
 - f. Design outside air flow
 - g. Actual outside air flow
 - h. Return air temperature
 - i. Outside air temperature
 - j. Required mixed air temperature
 - k. Actual mixed air temperature
 - l. Design outside/return air ratio
 - m. Actual outside/return air ratio

12. Exhaust Fan Data:
 - a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Air flow, specified and actual
 - f. Total static pressure (total external), specified and actual
 - g. Inlet pressure
 - h. Discharge pressure
 - i. Sheave Make/Size/Bore
 - j. Number of Belts/Make/Size
 - k. Fan RPM
13. Duct Traverse:
 - a. System zone/branch
 - b. Duct size
 - c. Area
 - d. Design velocity
 - e. Design air flow
 - f. Test velocity
 - g. Test air flow
 - h. Duct static pressure
 - i. Air temperature
 - j. Air correction factor
14. Terminal Unit Data:
 - a. Manufacturer
 - b. Type, constant, variable, single, dual duct
 - c. Identification/number
 - d. Location
 - e. Model number
 - f. Size
 - g. Minimum static pressure
 - h. Minimum design air flow
 - i. Minimum actual air flow
 - j. Maximum design air flow
 - k. Maximum actual air flow
 - l. Inlet static pressure
15. Air Distribution Test Sheet:
 - a. Air terminal number
 - b. Room number/location
 - c. Terminal type
 - d. Terminal size
 - e. Area factor
 - f. Design velocity
 - g. Design air flow
 - h. Test (final) velocity
 - i. Test (final) air flow
 - j. Percent of design air flow

END OF SECTION 230593

SECTION 230713 – DUCT INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Ductwork Insulation.
- B. Insulation jackets.

1.2 RELATED SECTIONS

- A. Division 23 Section “Identification for HVAC Piping and Equipment.”
- B. Division 23 Section “Metal Ducts”: Factory-insulated flexible ductwork.
- C. Division 23 Section “Metal Ducts”: Ductwork.

1.3 REFERENCES

- A. Division 01 Section “References”: Requirements for references and standards.
- B. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus.
- D. ASTM C209 - Standard Test Methods for Cellulosic Fiber Insulating Board.
- E. ASTM C356 - Standard Test Method for Linear Shrinkage of Preformed High-Temperature Thermal Insulation Subjected to Soaking Heat.
- F. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
- G. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- H. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- I. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- J. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation.
- K. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
- L. ASTM C1104 - Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.

- M. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
 - N. ASTM D1056 - Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
 - O. ASTM D1622 - Standard Test Method for Apparent Density of Rigid Cellular Plastics.
 - P. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - Q. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
 - R. ASTM E119 (UL 263) - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - S. ASTM E136 - Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C.
 - T. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.
 - U. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.
 - V. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
 - W. ISO 6944 - 1985 - Fire Resistance Tests - Ventilation Ducts.
 - X. NAIMA - National Insulation Standards.
 - Y. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
 - Z. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
 - AA. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
 - BB. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.
- 1.4 SUBMITTALS
- A. Division 01 Section "Submittal Procedures".
 - B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- 1.5 QUALITY ASSURANCE
- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years' experience.
 - B. Applicator Qualifications: Company specializing in performing the work of this Section with minimum 3 years' experience.

1.6 REGULATORY REQUIREMENTS

- A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255 and UL 723. For elastomeric foam insulation, rating shall apply for thicknesses up to 2 inches (50 mm).
- B. Insulation materials shall be asbestos free. No fibers with dimensions similar to asbestos fibers shall be released from any material.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Division 01 Section "Product Requirements": Transport, handle, store, and protect products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Division 01 Section "Product Requirements": Environmental conditions affecting products on site.
- B. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- C. Maintain temperature during and after installation for minimum period of 24 hours.

PRODUCTS

1.9 MANUFACTURERS

- A. Glass and Mineral Fiber Products:
 - 1. Knauf Insulation.
 - 2. Certainteed Corporation.
 - 3. Johns Manville.
 - 4. Owens Corning.
 - 5. No substitutions.
- B. Glass Fiber Insulation Sealing Tapes:
 - 1. Venture Tape Corporation.
 - 2. 3M Company.
 - 3. Ideal Tape Co., division of American Biltrite Inc.
 - 4. Nashua Tape Products, division of Berry Plastics Corp.
 - 5. No substitutions.
- C. Accessories:
 - 1. Ceel-Co division of Johns Manville (product: plastic jacket systems).
 - 2. Foster Products, division of Specialty Construction Brands, Inc., a subsidiary of H.B. Fuller (mastics, sealants, reinforcing membranes, and accessories).
 - 3. Johns Manville (products: Super-Seal acrylic polymer coatings, Zeston plastic jacket

- systems).
4. Pabco/Childers Metals, division of ITW Insulation Systems (products: metal jacket systems, and accessories).
 5. Vac Systems International (product: Tough Coat acrylic polymer mechanical insulation repair coating).
 6. Venture Tape Corporation (product: Jacket for outdoor insulation).

1.10 GLASS FIBER, FLEXIBLE

- A. Insulation: ASTM C553; flexible, noncombustible blanket.
1. 'K' ('Ksi') value: ASTM C518, 0.27 at 75 degrees F (0.039 at 24 degrees C).
 2. Maximum service temperature: 250 degrees F (121 degrees C) faced and 350 degrees F (176 degrees C) unfaced.
 3. Maximum moisture absorption: 0.20 percent by volume.
 4. Minimum density: 1.0 lb/cu. ft. (16 kg/m³).
- B. Vapor Barrier Jacket:
1. ASTM C1136, Kraft paper reinforced with glass fiber yarn and bonded to vapor barrier film. Facing as required for the application. Integral staple flap on one edge.
 - a. Aluminum Faced: FSK (aluminum foil-scrim-kraft) construction.
 - b. White Faced: PSK (polypropylene-scrim-kraft) construction.
 2. Moisture vapor transmission: ASTM E96; 0.02 perm.
 3. Suitable for insulation surface temperatures up to 150 degrees F (66 degrees C).
 4. Overlap longitudinal laps and butt strips.
 5. Secure with outward clinch expanding staples and vapor barrier mastic and pressure sensitive tape.
- C. Vapor Barrier Tape: See article "Glass Fiber Insulation Sealing Tape" in this Section.
- D. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- E. Tie Wire: Annealed steel, 16 ga (1.5 mm).

1.11 GLASS FIBER, RIGID

- A. Insulation: ASTM C612; rigid, noncombustible blanket. Supplied in board form.
1. 'K' ('Ksi') value: ASTM C518, 0.24 at 75 degrees F (0.036 at 24 degrees C).
 2. Maximum service temperature: 450 degrees F (232 degrees C).
 3. Maximum moisture absorption: 1.0 percent by volume.
 4. Density: 3.0 lb/cu. ft. (48 kg/cu m).
- B. Vapor Barrier Jacket:
1. ASTM C1136, kraft paper reinforced with glass fiber yarn and bonded to aluminized film. Facing as required for the application.
 - a. Aluminum Faced: FSK (foil-scrim-kraft) construction
 - b. White Faced: ASJ (all-service jacket) construction.
 2. Moisture vapor transmission: ASTM E96; 0.02 perm.
 3. Suitable for insulation surface temperatures up to 150 degrees F (66 degrees C).
 4. Overlap longitudinal laps and butt strips.
 5. Secure insulation with mechanical fasteners to substrate, and seal jacket with pressure sensitive tape.

- C. Vapor Barrier Tape: See article “Glass Fiber Insulation Sealing Tape” in this Section.
- D. Indoor Vapor Barrier Finish:
 - 1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight, glass fabric.
 - 2. Vinyl emulsion type acrylic, compatible with insulation.

PART 2 - EXECUTION

2.1 EXAMINATION

- A. Division 01 Section “Project Management and Coordination”: Verification of existing conditions before starting work.
- B. Verify that ductwork has been tested before applying insulation materials.
- C. Verify that surfaces are clean, foreign material removed, and dry.
- D. Verify that insulation materials are clean and dry. Discard any materials that exhibit signs of moisture damage, contamination, mold, mildew, or other biological growth. Discard any materials used in the air handling airstream if they have been exposed to water.

2.2 INSTALLATION

- A. Division 01 Section “Quality Requirements”: Manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. In addition to new ductwork, provide insulation for surfaces of existing ductwork that is uninsulated. Field-verify scope of existing ductwork.
- D. Provide insulation for surfaces of ductwork, as indicated and specified. Insulation values shall meet or exceed the requirements of ASHRAE 90.1-2010, State Energy Codes, and Table I, whichever is greater. In addition, comply with the other requirements of this Section.
- E. Insulated Ductwork:
 - 1. Provide insulation with vapor barrier jackets.
 - 2. Finish with tape and vapor barrier jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- F. Ductwork Exposed below 10 feet (3 meters) above finished floor in Mechanical Equipment Rooms or below 8 feet (2.4 meters) above finished floor in Finished Spaces: Provide glass fiber rigid insulation with vapor barrier jacket. It is not required to insulate ductwork which is acoustically lined, unless otherwise specified or indicated on the Drawings.
- G. Do not insulate exposed heating or cooling supply ductwork in the conditioned spaces which it serves, unless otherwise specified or indicated on the Drawings.
- H. Wherever exposed ductwork for air conditioned systems passes through non air conditioned spaces, insulate ductwork with glass fiber rigid insulation with vapor barrier, to prevent

condensation.

- I. Inspection Plates and Test Holes: Provide, where required, in ductwork or casings for balance measurements. Test holes shall be factory fabricated, airtight, and noncorrosive with screw cap and gasket. Extend cap through insulation.
- J. Install insulation after ductwork and equipment have been tested and approved.
- K. Ensure that surface is clean and dry prior to installation. Ensure that insulation is dry before and during application. Finish with system at operating conditions.
- L. Ensure that insulation is continuous through inside walls. Pack around ducts with fireproof self-supporting insulation material, properly sealed.
- M. Finish insulation neatly at hangers, supports and other protrusions.
- N. Locate insulation or cover seams in least visible locations.
- O. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.
- P. Standing seams, supporting angles and flanges on insulated ductwork shall be insulated with thickness equal to the duct and edges shall be finished and vapor sealed.
- Q. For supply or return ductwork which is required to be insulated, insulation shall be continuous and shall include the insulating of register, grille and diffuser connection plenums/boots.
- R. Mechanical fasteners shall not be riveted or screwed to the duct and shall not penetrate the metalwork.

2.3 PAINTING AND IDENTIFICATION

- A. Paint in accordance with Division 09 Section "Painting."

2.4 FIELD INSPECTION

- A. Visually inspect to ensure that materials used conform to Specifications. Inspect installations progressively for compliance with requirements.

TABLE I
DUCTWORK INSULATION MATERIAL AND WALL THICKNESS

DUCTWORK TYPE	INSULATION MATERIAL	VAPOR BARRIER REQUIRED	INSULATION WALL THICKNESS
Supply ductwork	Glass Fiber, Flexible	Yes	1 ½ inches (38.1 mm)
	Glass Fiber, Rigid	Yes	1 inch (25.4 mm)
Exposed supply ductwork for cooling systems that pass through non air-conditioned spaces	Glass Fiber, Rigid	Yes	1 inch (25.4 mm)
Exposed supply ductwork in mechanical or equipment rooms	Glass Fiber, Rigid	No for heating only systems, Yes for cooling systems	1 inch (25.4 mm)
Supply, return and exhaust ductwork in cold attic spaces, crawl spaces or any space outside of the building insulation envelope but within the building shell and protected from weather	Glass Fiber, Flexible	No for heating only systems, Yes for cooling systems	2 inches (50.8 mm)
	Glass Fiber, Rigid	No for heating only systems, Yes for cooling systems	2 inches (50.8 mm)
Ductwork 10 feet upstream and downstream from a fan, or through the first elbow, whichever is longer (excluding fresh air intake ductwork and ductwork within 10 feet downstream of a cooling coil or humidifier)	[Elastomeric Foam Duct Liner] [or Polyimide Foam] [Glass Fiber Duct Liner, Rigid]	--	1 inch (25.4 mm)

END OF SECTION 230713

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SECTION 230719 – HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.
- C. Shields, Inserts, and Saddles.

1.2 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures”.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years’ experience.
- B. Applicator Qualifications: Company specializing in performing the work of this Section with minimum 3 years’ experience.

1.4 REGULATORY REQUIREMENTS

- A. Conform to maximum flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255 and UL 723. For elastomeric foam insulation, rating shall apply for thicknesses up to 2 inches.
- B. Insulation materials and accessories shall be asbestos-free. No fibers with dimensions similar to asbestos fibers shall be released from any material.

1.5 DELIVERY, STORAGE, AND PROTECTION

- A. Division 01 Section “Product Requirements”: Transport, handle, store, and protect products.
- B. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Division 01 Section “Product Requirements”: Environmental conditions affecting products on site.
- B. Maintain ambient conditions required by manufacturers of each product.
- C. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Elastomeric Foam Products:
 - 1. Armacell LLC.
 - 2. K-Flex USA.
 - 3. No substitutions.

- B. Glass and Mineral Fiber Products:
 - 1. Knauf Insulation.
 - 2. Certainteed Corporation.
 - 3. Johns Manville.
 - 4. Owens Corning.
 - 5. No substitutions.

- C. Accessories:
 - 1. Ceel-Co division of Johns Manville (product: plastic jacket systems).
 - 2. Foster Products, division of Specialty Construction Brands, Inc., a subsidiary of H.B. Fuller (mastics, sealants, reinforcing membranes, and accessories).
 - 3. Johns Manville (products: Super-Seal acrylic polymer coatings, Zeston plastic jacket systems).
 - 4. Proto Corporation (product: plastic jacket systems).
 - 5. Vac Systems International (product: Tough Coat acrylic polymer mechanical insulation repair coating).

2.2 GLASS FIBER

- A. Insulation: ASTM C547; rigid molded, noncombustible.
 - 1. 'K' ('Ksi') value: ASTM C177, 0.24 Btu-in/(hr-sq.ft-°F) at 75°F.
 - 2. Maximum service temperature: 850°F.
 - 3. Maximum moisture absorption: 0.2 percent by volume.

- B. Vapor Barrier Jacket:
 - 1. ASTM C1136, White kraft paper with glass fiber yarn, bonded to aluminized film.
 - 2. Moisture vapor transmission: ASTM E96; 0.02 perm-inches.

- C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

- D. Vapor Barrier Lap Adhesive: Compatible with insulation.

- E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

- F. Indoor Vapor Barrier Finish:
 - 1. Cloth: Untreated; 9 oz/sq yd weight.
 - 2. Vinyl emulsion type acrylic, compatible with insulation, white color.

- G. Insulating Cement: ASTM C449/C449M.

2.3 ELASTOMERIC FOAM

- A. Products:
1. Armacell: AP Armaflex and AP Armaflex FS pipe and sheet insulation.
 2. K-Flex USA: Insul-Tube and K-Flex LS pipe insulation, and Insul-Sheet S2S and K-Flex LS sheet insulation.
 3. No substitutions.
- B. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.
1. 'K' ('Ksi') value: ASTM C177; 0.277 Btu-in/(hr-sq.ft- degrees F) at 75 degrees F (0.04 W/m-K at 24 degrees C).
 2. Minimum service temperature: -70 degrees F (-57 degrees C) (flexible to -20 degrees F (-29 degrees C)).
 3. Maximum service temperature: 220 degrees F (104 degrees C).
 4. Maximum moisture absorption: ASTM C209, 0.2 percent by volume; or ASTM D1056, 5 percent by weight.
 5. Moisture vapor transmission: ASTM E96; 0.08 perm-inches (0.116 ng/(s-m-Pa)).
 6. Connection: Waterproof vapor barrier adhesive.
- C. White Insulation for Exposed Locations: Where exposed to the occupants' view, provide insulation in white or off-white color, Armacell's AP/Armaflex W or K-Flex USA's Insul-Tube White and Insul-Sheet White.
- D. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.
- E. Insulated Hanger Inserts: At Contractor's option, Armacell Armafix IPH insulated pipe hanger inserts may be used at hanger locations.
1. Engineered from Armaflex insulation, with inserts of CFC-free PPUR/PIR polyurethane foam insulation bearing segments.
 2. Outer shell of 30 mils (0.76 mm) -thick painted aluminum.
 3. Self-adhesive closure strip.
- F. Provide Armaflex insulation tape, wrapped around the IPH prior to placing in the hanger.

2.4 FIELD-APPLIED JACKETS

- A. Aluminum Jacket: ASTM B209, ASTM B209M.
1. Thickness: 0.016 inch sheet.
 2. Finish: Corrugated.
 3. Joining: Longitudinal slip joints and 2 inch laps.
 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.
 6. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

2.5 SHIELDS, INSERTS, AND SADDLES

- A. Shields:
1. Carpenter and Paterson Figure 265GS, or equal.
 2. Galvanized or electro-galvanized steel, minimum 12 inch length, minimum 120-degree arc, minimum 18 gauge.
 3. Provide contact adhesive to glue shields to the insulation.

- B. Snap-On Shields:
 - 1. Cooper B-Line "Snap'N Shield".
 - 2. Snap-N Shield is an acceptable substitute for metal shields when installed with strut trapeze hangers on horizontal piping.
 - 3. Paintable polypropylene plastic 12-inch long preformed shields, snap-on design for attachment to strut.
 - 4. Gluing is not required with Snap-N Shield.
 - 5. Provide black or white color to match the insulation in areas exposed to public view.

- C. Inserts:
 - 1. Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 2. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

- D. Saddles:
 - 1. Factory fabricated of curved carbon steel plate, of same overall thickness and contour as adjoining insulation. Sides designed for welding to pipe. Center support plate for pipe sizes 12 inches and larger.

2.6 MANUFACTURER'S STAMP OR LABEL

- A. Every package or standard container of insulation, jackets, cements, adhesives, and coatings delivered to the project site for use shall have the manufacturer's stamp or label attached giving name of manufacturer, brand, and description of material. Insulation packages and containers shall be asbestos-free.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

- A. Division 01 Section "Quality Requirements": Manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards where applicable.
- C. Provide insulation for surfaces of new piping and for surfaces of existing piping that is uninsulated, as indicated and specified.
- D. Insulation values shall meet or exceed the requirements of ASHRAE 90.1-2010, applicable State Energy Codes, and Table I, whichever is greater. In addition, comply with the other requirements of this Section.
 - 1. International Energy Conservation Code (IECC): Chapter 5 of the Code allows the use of ASHRAE 90.1 insulation thicknesses instead of the Minimum Pipe Insulation table which is in Chapter 5 of the IECC. This Specification does not reference the table in IECC.

- E. Piping systems requiring insulation, types of insulation required, and insulation thickness shall be as listed in Table I herein. For piping not listed in Table 1, insulate to meet Code requirements, using suitable specified materials, subject to Architect's approval. Except for flexible unicellular insulation, insulation thicknesses as specified in Table I shall be one inch greater for insulated piping systems located outside the building and in unconditioned spaces. Unless otherwise specified, insulate fittings, flanges, and valves, except valve stems, hand wheels, and operators. Use factory pre-molded, precut, or field-fabricated insulation of the same thickness and conductivity as used on adjacent piping. Insulation exterior shall be factory cleanable, grease resistant, non-flaking, and non-peeling.
- F. Exposed Piping: Locate insulation and cover seams in least visible locations.
- G. Insulated Pipes Conveying Fluids Below Ambient Temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- H. Glass Fiber Insulated Pipes Conveying Fluids below Ambient Temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- I. For hot piping conveying fluids 140°F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- J. For hot piping conveying fluids over 140°F, insulate flanges and unions at equipment.
- K. Glass Fiber Insulated Pipes Conveying Fluids above Ambient Temperature:
 - 1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- L. Large Valve Bodies and Other Fittings: Large valves and other fittings requiring service access may be insulated with removable, reusable equipment covers with "Velcro" closures.
- M. Branches to Expansion Tanks: For chilled water systems, insulate completely. For hot water systems, insulate from the connection at the main to at least 10 feet toward the tank.
- N. Branches to Gauges, Sensors, Drains, and Vents: Insulate branches to gauges, sensors, drains, and vents as for active sections of piping. For piping with operating temperatures above ambient, insulate to at least 6 inches from the active main. For temperature devices, insulate to include the sensing bulb or other element. For pressure devices in hot piping with syphon loops, insulate from the active main to the syphon loop, but it is not necessary to insulate the syphon loop or the portion of the branch on the device side of the syphon loop.
- O. Shields, Inserts, and Saddles:
 - 1. Application: Provide shields at hangers. Provide inserts for piping 2 in. nominal size or larger.
 - 2. Shield location: Between insulation jacket and hanger.

3. Insert location: Between support shield and piping and under the finish jacket.
 4. Saddle location: Between support shield and piping.
 5. Glue shields to outside of insulation after system is filled and run at operating temperature.
 6. Align mid-length of shields, inserts, and saddles with the hanger centerline.
- P. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions.
- Q. Pipe Exposed in Mechanical Equipment Rooms 10 feet or Less Above Finished Floor:
1. Piping Which Crosses Walking and Service Access Paths 4 feet or Less Above Finished Floor: Finish with aluminum jacket and fitting covers.
 2. Other Piping: Finish with aluminum jacket and fitting covers.
- R. Piping installed outside of building shall be finished with aluminum jacket and fitting covers.

3.3 UNIFORM INSTALLATION

- A. Systems shall use a single insulation type throughout the installation.

3.4 PREPARATION

- A. Insulate piping after system tests have been completed and surfaces to be insulated have been cleaned of dirt, rust, and scale and dried. Ensure full range of motion of equipment actuators. Modify insulation to avoid obstruction of valve handles, safety reliefs, and other components requiring movement. Allow adequate space for pipe expansion. Install insulation with jackets drawn tight and cement down on longitudinal and end laps. Do not use scrap pieces where a full length section will fit. Insulation shall be continuous through sleeves, wall and ceiling openings. Extend surface finishes to protect surfaces, ends, and raw edges of insulation. Apply coatings and adhesives at the manufacturer's recommended coverage per gallon. Individually insulate piping. Provide a moisture and vapor seal where insulation terminates against metal hangers, anchors and other projections through the insulation on surfaces for which a vapor seal is specified. Keep insulation dry during the application of any finish. Bevel and seal the edges of exposed insulation. Unless otherwise indicated, do not insulate the following:
1. Piping in radiation enclosures, or within cabinets of unit heaters.
 2. Valve hand wheels.
 3. Fire protection pipes. Vibration isolating connections.
 4. Adjacent insulation.
 5. ASME stamps.

3.5 PIPING INSULATION

- A. Pipe Insulation (Except Elastomeric Insulation): Place sections of insulation around the pipe and joints tightly butted into place. The jacket laps shall be drawn tight and smooth. Secure jacket with fire resistant adhesive, factory applied self-sealing lap. Cover circumferential joints with butt strips, not less than 3-inches wide, of material identical to the jacket material. Overlap longitudinal laps of jacket material not less than 1-1/2 inches. Adhesive used to secure the butt strip shall be the same as used to secure the jacket laps. When a vapor barrier jacket is required, as indicated in Table I, or on the ends of sections of insulation that butt against flanges, unions, valves, fittings, and joints, use a vapor-barrier coating conforming to manufacturer's weatherproof coating for outside service. Apply this vapor barrier coating at longitudinal and circumferential laps. Patch damaged jacket material by wrapping a strip of jacket material around the pipe and cementing, and coating as specified for butt strips. Extend the patch not less than 1-1/2 inches past the break in both directions.

At penetrations by pressure gauges and thermometers, fill the voids with the vapor barrier coating for outside service. Seal with a brush coat of the same coating. Where penetrating roofs, insulate piping to a point flush with the top of the flashing and seal with the vapor barrier coating. Butt tightly the exterior insulation to the top of the flashing and interior insulation. Extend the exterior metal jacket 2 inches down beyond the end of the insulation. Seal the flashing and counterflashing underneath with the vapor barrier coating.

- B. Sleeves and Wall Chases: Where penetrating interior walls, extend a metal jacket 2 inches out on either side of the wall and secure on each end with a band. Where penetrating floors, extend a metal jacket from a point below the back-up material to a point 10 inches above the floor with one band at the floor and one not more than one inch from end of metal jacket. Where penetrating exterior walls, extend the metal jackets through the sleeve to a point 2 inches beyond the interior surface of the wall.
- C. Elastomeric Foam Insulation: Bond cuts, butt joints, ends, and longitudinal joints with adhesive. Miter 90-degree turns and elbows, tees, and valve insulation. Where pipes penetrate fire walls, provide mineral-fiber insulation inserts and sheetmetal sleeves. Insulate flanges, unions, valves, and fittings in accordance with manufacturer's published instructions. Apply two coats of vinyl lacquer finish to elastomeric foam insulation before applying PVC jacket in outside locations.

3.6 FIELD INSPECTION

- A. Visually inspect to ensure that materials used conform to specifications. Inspect installations progressively for compliance with requirements.

TABLE I
PIPING INSULATION MATERIAL AND WALL THICKNESS

SERVICE	INSULATION MATERIAL	VAPOR BARRIER REQUIRED	INSULATION WALL THICKNESS AT THE FOLLOWING PIPE DIAMETERS				
			<1 inch	1 inch to <1.5 inches	1.5 inches to <4 inches	4 inches to <8 inches	8 inches or Greater
Air Conditioning Condensate Drain Located Inside Building	Elastomeric Foam	N/A	0.75 inches	0.75 inches	1 inch	1.5 inches	1.5 inches
	Glass Fiber	Yes	0.75 inches	0.75 inches	1 inch	1.5 inches	1.5 inches
Refrigerant Suction and Liquid Piping							
Operating Temperature							
40 degrees F to 60 deg. F	Elastomeric Foam	N/A	0.75 inch	1 inch	1 inch	1.5 inches	2 inches
Below 40 degrees F	Elastomeric Foam	N/A	1 inch	1 inch	1 inch	1.5 inches	2 inches
Heating Systems (Steam, Steam Condensate, Hot Water Supply and Return)							
251 degrees F to 350 deg. F	Glass Fiber	No	3 inches	4 inches	4.5 inches	4.5 inches	4.5 inches
201 degrees F to 250 deg. F	Glass Fiber	No	2.5 inches	2.5 inches	2.5 inches	3 inches	3 inches
141 degrees F to 200 deg. F	Glass Fiber	No	1.5 inches	1.5 inches	2 inches	2 inches	2 inches
105 degrees F to 140 deg. F	Glass Fiber	Yes	1 inch	1 inch	1.5 inches	1.5 inches	1.5 inches

END OF SECTION 230719

SECTION 230900 – INSTRUMENTATION AND CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Direct Digital Control (DDC) equipment.
- B. Software.
- C. Installation.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Access Doors.
- B. Valves - piping connections.
- C. Pressure taps.
- D. Thermal wells.
- E. Dampers - ductwork connections.

1.3 SYSTEM DESCRIPTION

- A. A fully integrated Automatic Temperature Control (ATC) Building Management and Control System incorporating Direct Digital Control (DDC), energy management, equipment monitoring, and control consisting of the following:
 - 1. Microcomputer-based equipment controllers interfacing directly with sensors, actuators and environmental delivery systems.
 - 2. Electric controls and mechanical devices for items indicated on Drawings and described hereinafter including dampers, valves, and motor drives.
 - 3. Microcomputer-based terminal controllers interfacing with sensors, actuators, and terminal equipment control devices.
- B. Submittals, data entry, electrical installation, programming, start up, test and validation, instruction of Owner's representative on maintenance and operation, as built documentation, and system warranty.
- C. System Summary:
 - 1. The intent of this project is to provide an addition to the existing ATC system with electronic actuators for the renovated portions of the building.
 - 2. For existing pneumatically controlled equipment which is to remain and which requires temporary removal, modifications or relocation, provide pneumatic tubing and associated controls as required to return equipment to its original operating conditions.
 - 3. Air handling units, rooftop HVAC units, unit ventilators and terminal heating units which are designated to be controlled by a temperature sensor shall be interfaced with the DDC system, such that monitoring and setpoint adjustment shall be accomplished through the graphical user interface at the operator workstation.

4. ATC Contractor shall coordinate closely with Commissioning Authority for manipulation and functional testing of mechanical systems.

1.4 SUBMITTALS

- A. Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Submittal Shall Consist of:
 1. Qualifications of Supplier/Manufacturer/Installer.
 2. System architecture indicating digital devices.
 3. Data sheets of products.
 4. Valve, damper, and well and tap schedules indicating size, configuration, capacity, and location of equipment.
 5. Wiring and piping interconnection diagrams including panel and device power and sources.
 6. Equipment lists of proposed devices and equipment.
 7. Software design data including flowchart of each direct digital control program showing interrelationship between inputs, outputs, PID functions, and other functions.
- C. Codes and Approvals:
 1. The complete temperature control installation shall be in strict accordance to the national and local electrical codes and the electrical Division of these Specifications. Devices designed for or used in line voltage applications shall be UL listed. Microprocessor based remote and central devices shall be UL916 Listed.
 2. Electronic equipment shall conform to the requirements of FCC regulation Part 15, Section 15 governing radio frequency electromagnetic interference and be so labeled.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01 Section "Operation and Maintenance Data."
- B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
- C. Manuals: Provide the following:
 1. An Operator's Manual with graphic explanations of keyboard use for operator functions specified under Operator Training.
 2. Computerized printouts of equipment controller's data file construction including point processing assignments, physical terminal relationships, scales and offsets, command and alarm limits, and others as applicable.
 3. A manual including revised as-built documents of materials required under the paragraph "SUBMITTALS" in this Specification Section.
 4. Two Operators Manuals and two As-Built Manuals shall be provided to the Owner.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01 Section "Project Requirements."

1.7 WARRANTY

- A. Components, system software, parts, and assemblies furnished under this Section shall be guaranteed against defects in materials and workmanship for one year from acceptance date.
- B. Labor to troubleshoot, repair, reprogram, or replace system components shall be provided at no charge to the Owner during the warranty period.
- C. Corrective software modifications made during warranty service periods shall be updated on user documentation and on user and manufacturer archived software disks.

PART 2 - PRODUCTS

2.1 ACCEPTABLE SUPPLIERS

- A. Acceptable Manufacturers and Installers:
 - 1. Johnson Controls, installed by Trident Controls Inc., 187 Gray Road, Unit A, Cumberland, ME 04021.
 - 2. TAC, I/A Series, installed by Maine Controls, 400 Presumpscot Street, Portland, ME
 - 3. Delta, installed by IB Controls, 3 Pope Road, Windham, ME 04062
 - 4. Siemens, 66 Mussey Road, Scarborough, ME 04074
 - 5. No other substitutions will be permitted.
- B. The Temperature Control Contractor (or Subcontractor) shall hereinafter be referred to as the ATC Contractor.

2.2 SYSTEM REQUIREMENT

- A. Provide complete direct digital and electronic control system consisting of temperature sensors, thermostats, control valves, dampers, operators, indicating devices, interface equipment, and other apparatus required to operate mechanical system and to perform functions specified. Provide controls for the following:
 - 1. Air handling systems.
 - 2. Baseboard Radiation and Radiant Heating Panels.
 - 3. Exhaust fans.
 - 4. Graphical workstation.
 - 5. Provide hardware and software required for remote monitoring of the ATC system through modem interface.

2.3 THERMOSTATS

- A. Freezestats safety low limit shall be duct-mounted [just downstream of the heating coil], manual reset and automatic reset twenty foot limited fill type responsive to the coolest section of its length.
- B. Electric thermostats shall be line voltage or low voltage type, suitable for the application. They shall have concealed setpoint adjustment and setpoint indicator.
- C. Unit heater aquastats shall be strap-on type.

2.4 TEMPERATURE SENSORS

- A. Temperature sensors shall provide a two-wire connection to the controller that is polarity and wire type insensitive. Sensors shall have communications jacks for connection to the communication trunk to which the controller is connected. The temperature sensor, the connected controller, and other devices on the communications bus shall be accessible by the Graphical Programming tool.
- B. Provide with manual adjustment dials, which shall be programmable through the operator workstation to allow a maximum and minimum range for user adjustment. The max/min range shall initially be set at 68°F min/72°F max.
- C. Provide with override buttons which, when depressed during unoccupied time periods, will override the zone's temperature controls and setpoints to occupied conditions for a user adjustable period of time (initially set for 2 hours).

2.5 AUTOMATIC DAMPERS

- A. Manufacturers:
 - 1. Ruskin.
 - 2. Arrow.
 - 3. Greenheck.
 - 4. American Warming & Ventilating.
 - 5. Nailor
- B. Provide automatic control dampers not specified to be integral with other equipment.
- C. Dampers shall be ultra-low leakage type, with blade edges fitted with replaceable inflatable seals to limit damper leakage to 6 CFM per square foot at 1 in. w.g. Side seals shall be stainless steel of the tight-seal spring type.
- D. Dampers in Galvanized Steel Ductwork:
 - 1. For applications not exceeding 36 inches blade length in an individual section, 1,500 fpm face velocity, 2.5 in. w.g. total system static pressure, and 180°F operating temperature, dampers shall be equal to Ruskin model CD-36, low leakage type with roll-formed blades. Blades shall be not less than 16-gauge (1.6 mm) galvanized steel, with PVC-coated polyester fabric edge seals mechanically locked into blade edges.
 - 2. For applications exceeding any of the criteria listed above, dampers shall be equal to Ruskin model CD-60, low leakage type with high-performance airfoil blades. Blades shall be double-skin construction of 14 gauge (2.0 mm) equivalent thickness, with extruded Ruskiprene (TPR) (or equal) blade edge seals locked into blade edges. Dampers shall be suitable for 60 inches maximum single-section width, 6,000 fpm face velocity, up to 11 in. w.g. static pressure (8.5 in. w.g. total system pressure requires maximum section width of 36 inches), and operating temperature range of -72°F to 275°F.
 - 3. Frames shall be not be less than 13-gauge (2.28 mm) galvanized steel, or shall be fabricated of 16-gauge (1.6 mm) galvanized steel hat channel reinforced with corner braces for structural strength equal to 13-gauge channel frames..
- E. Dampers in Aluminum Ductwork:
 - 1. Dampers shall be equal to Ruskin CD-50, low leakage type with high-performance airfoil blades. Blades shall be heavy-gauge extruded aluminum, with extruded Ruskiprene (TPR) (or equal) blade edge seals locked into blade edges. Dampers shall be suitable for 60 inches

maximum single-section width, 6,000 fpm face velocity, up to 11 in. w.g. static pressure (8.5 in. w.g. total system pressure requires maximum section width of 36 inches), and operating temperature range of -72°F to 275°F.

2. Frames and blades shall be of 6063T5 aluminum alloy. Frames shall have minimum wall thickness of 0.125 inches.
- F. Blades shall not be over 8 inches wide. Bearings shall be oilite, stainless steel sleeve, ball-bearing, or nylon. Blade axles shall be 2" plated steel hex rods. Control shafts shall be 2" diameter, 6 inches long, removable. Multiple-section dampers shall have factory-installed jackshafts.
- G. Frames channels shall not exceed 1-inch high for damper heights over 12 inches, and shall not exceed 1/2-inch high for damper heights 12 inches and less.
- H. Proportional control dampers shall be opposed blade type; two-position dampers shall be parallel blade type.
- I. Dampers shall be fabricated of materials that are similar to the ductwork in which they are installed. Provide non-electrically-conductive material between dissimilar metals.
- J. Dampers that are located in outside walls or in roof line that are 10 sq ft or larger shall be insulated. Dampers shall be equal to Tamco Series 9000, thermally insulated dampers.
- K. Submittals: Submit construction specifications, pressure, velocity, and temperature ratings, and leakage data. Submit a schedule of damper sizes indicating size, location, and face velocity, with required torque for selection of actuators.

2.6 AUTOMATIC CONTROL VALVES

- A. Automatic control valves 2-1/2" (64 mm) and smaller shall be screwed type; valves 3" (76 mm) and larger shall be flanged. Valves shall be ANSI-rated to withstand the pressures and temperatures encountered.
- B. Unitary valves shall be straight-through type. Stems shall be polished stainless-steel and packing shall be Teflon suitable for chilled water service, hot water service up to 217 psi (1495kPa) at 250°F (121°C), and steam service up to 100 psi (689 kPa) at 337°F (169°C). Seating shall be Teflon or composition disc for water service, and metal-to-metal for steam service. [Rubber-paddle-type valves such as Erie valves or Honeywell zone valves are not allowed.] [Valves with thermal wax motors are not allowed.]
- C. Honeywell Asmall linear control valves with Alinear valve actuators (or equal) may be used only for VAV box coils and hot water duct coils; they may not be used for other coil types.
- D. Provide modulating straight-through water valves with equal-percentage contoured throttling plugs. If ball valves are used, they shall be by Belimo, no substitutions, with equal percentage disks.
- E. Modulating valves shall be sized for a pressure drop equal to the coil they serve but not to exceed 3 psi (20.7 kPa). Two-position valves shall be line sized.

2.7 DAMPER AND VALVE ACTUATORS

- A. Damper and valve actuators shall be by BELIMO or approved equal. Actuators shall satisfy the following requirements:
1. Electronic direct-coupled actuation shall be provided on dampers and valves.
 2. The actuator shall be direct-coupled, enabling it to be mounted directly to the damper or valve without the need for connecting linkage. The fastening clamp assembly shall be of a "V" bolt design with associated "V" shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a "V" clamp assembly of sufficient size to be directly mounted to an integral jack-shaft of up to 1.05 inches (26 mm) when the damper is constructed in this manner. Set-screw type fasteners are not acceptable.
 3. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.
 4. For power-failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable.
 5. Proportional actuators shall provide a standard built-in 2 to 10 VDC position feedback signal, and other types of actuators shall be capable of providing an optional position feedback signal.
 6. 24 VAC/VDC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 watts for DC applications. Actuators operating on 120 VAC power shall not require more than 10 VA. Actuators operating on 230 VAC power shall not require more than 11 VA.
 7. Actuators shall be provided with a conduit fitting and a minimum three-foot electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
 8. Actuators used near outdoor air streams shall have a NEMA 2 rated housings for water and moisture resistance. Other actuators shall have NEMA 1 rated housings.
 9. Actuators shall produce no more than a 45 dB(A) noise level when powered and operating, and no more than a 62 dB(A) noise level when in the spring return mode.
 10. Actuators shall be Underwriters Laboratories Standard 873 listed and Canadian Standards Association Class 4813 02 certified as meeting correct safety requirements and recognized industry standards.
 11. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 2-year manufacturer's warranty, starting from the date of installation. Manufacturer shall be ISO9001 certified.
 12. Manual Override:
 - a. Non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered.
 - b. Spring return actuators shall have a manual crank at each actuator. If a loose-fit manual lever such as an Allen wrench serves as the manual crank, attach it to the actuator so it is in place for Testing and Balancing, for Commissioning, and when the system is turned over to the Owner.
- B. Automatically controlled devices, unless specified otherwise elsewhere, shall be provided with electric actuators sized to operate their appropriate loads with sufficient reserve power to provide smooth modulating action or two-position action and tight close-off.

- C. Where two or more actuators are to be operated in sequence with each other, sequencing shall be by digital sequencing with separate analog outputs, as specified in the sequence of operation.
- D. Unless otherwise indicated, actuators shall be spring loaded and shall, upon a loss of power, actuate their device to an appropriate fail safe position.
 - 1. Hot water valves - fail safe to fully open
 - 2. Outside and exhaust air dampers - fail safe to fully closed
 - 3. Exhaust fan motorized dampers - fail safe to fully closed
 - 4. Return air dampers - fail safe to fully open
- E. For actuators that are required to “fail safe”, provide spring return actuators. A floating point@ actuators shall not be allowed for these applications. “Floating point” actuators shall be allowed for actuators that are not required to “fail safe”.

2.8 CURRENT TRANSFORMERS

- A. Current transformers (CTs) are not an acceptable substitute for pump or fan monitoring where flow switches or pressure switches are specified.

2.9 DATA INPUTS AND OUTPUTS

- A. Input/output sensors and devices shall be closely matched to the requirements of the remote panel for accurate, responsive, noise-free signal input/output. Control input response shall be high sensitivity and matched to the loop gain requirements for precise and responsive control.
- B. Duct temperature sensors shall be rigid stem or averaging type as required. Provide water sensors with a separable copper, monel or stainless-steel well.
- C. Differential and Static Pressure Sensors and Switches:
 - 1. Fan proof-of-flow switches shall be adjustable set point and differential pressure type. Current sensors shall be allowed, provided that they are capable of detecting a belt break.
 - 2. Pump proof-of-flow switches shall be adjustable differential pressure type.
- D. Control relays and analog output transducers shall be compatible with equipment controllers output signals. Relays shall be suitable for the loads encountered. Analog output transducers shall be designed for precision closed loop control with pneumatic repeatability error no greater than 12%.
- E. Data inputs and outputs shall be compatible with variable frequency drives; see Division 23 Section “Motors, Drives, and Accessories”.

2.10 TEMPERATURE CONTROL CENTRAL HARDWARE

- A. Operator Workstations: The central operator workstation shall be included in this project. Coordinate with Owner for exact location. Operator workstation shall meet the following minimum criteria:
 - 1. Operator workstation shall be Compaq, Dell, Gateway, Hewlett Packard, or IBM. No substitutions.
 - 2. Operating System: MS Windows 7 Professional operating system. Windows Vista may be provided, but only if required by the control system. Windows XP and older versions are not allowed. (Operating systems that provide only foreground/background operation, or are based on concurrent DOS, are unacceptable and will be rejected.)

3. Processor: Intel Pentium dual-core.
 4. RAM: The system shall come standard with at least 256K RAM disk cache and 1 gigabytes of system RAM. Provide 4 DIMM slots with capacity for up to 2 GB.
 5. High Resolution Color Monitor: Provide with a 19" LCD flat panel 0.29 dot pitch Super VGA (1280 X 1024 resolution @60, 75 Hz) color monitor and driver.
 6. Video Card: 256 megabyte of video RAM, dual-monitor capability, Blu-ray disc compatibility.
 7. Hard Drive: 160 GB capacity. 7,200 RPM, 10 millisecond average access time.
 8. DVD +/- RW Drive: Read/write 48xCD/16xDVD drive, with CD creator software.
 9. CD-RW/DVD-ROM Drive: Combination 48xCD-RW/16xDVD-ROM drive.
 10. Optional Zip Drive: An internal 250 MB zip drive or equivalent, for the purpose of manually and automatically backing up fixed system data, may be provided at Contractor's option.
 11. Floppy Disk Drive: 1.44 megabyte storage, 3.5" disk size. At the Control Contractor's option, an integral multi-card reader may be substituted.
 12. Mouse and Keyboard: High quality bus or serial mouse with at least 3 buttons and scroll wheel. 104-key keyboard. Either mouse or keyboard shall be able to be utilized interchangeably for operator interface.
 13. Modem: 56K baud phone/fax modem. At the Control Contractor's option, the phone/fax modem may be provided in the master control panel in lieu of in the operator workstation. If the phone/fax modem is located in the master control panel, the control Contractor shall be responsible for costs associated with locating a dedicated telephone line to the appropriate location to allow for remote access to the ATC system.
 14. Ethernet Interface: 10/100 speed.
 15. USB Ports: 8 total, 2 front, 6 back.
 16. Printer: Epson LX-300, 9-pin parallel dot-matrix type printer; tractor feed; 80 column; 337 cps in draft mode; 10-inch maximum paper width; 49 dB sound level; 6,000-hour MTBF (mean-time-between-failure) rating; up to 4 million strokes per wire; with serial, parallel, and USB ports. For reports, alarms and exception messages. Provide one box of tractor-feed paper, and one spare black ribbon cartridge.
 17. Accessories: Provide interconnecting cables and other accessories as required.
 18. Where applicable, provide standard RS232 serial communications port for use with lighting control software (lighting control software by Division 26).
 19. Security Software: Install anti-virus, anti-spyware, and firewall software provided by the Owner. Contact the Owner for requirements.
- B. Equipment controllers shall be 16 bit microprocessor based with EPROM operating system (O.S.). ATC programs and data files shall be non-volatile EEPROM or flash memory to allow simple additions and changes. Each equipment controller shall have an on-board real-time clock with battery backup of a minimum of 30 days.
1. Equipment controllers shall be provided where indicated or specified with capacity to accommodate input/output (I/O) points required for the application plus spare points specified. These panels shall be configured with analog and digital inputs and outputs, and pulse counting totalizers and such that the primary input, the output and control logic shall be resident in a single microprocessor to provide network independent stand-alone closed loop ATC.
 2. Panel electronics shall be installed in suitable enclosures. Equipment room panels shall have hinged doors and shall also contain the load relays, transducers, and associated equipment.
- C. Terminal Equipment Controllers shall be EEPROM based and modularity expandable to accommodate additional points if required for future functional changes or enhancements, and with

I/O selected for the application plus specified spares. Terminal controllers shall be capable of processing sensor signals of the applications specified, and shall have capability to drive digital (on-off), pulse width modulation, and true analog (0-10V) outputs. Terminal Controller enclosures shall be compact, finished steel to fit within or on terminal equipment. Each terminal controller shall have complete standalone capability.

2.11 OPERATOR STATION SOFTWARE

- A. Operator Station (OS) software shall include as a minimum the Operating System, Data Base Manager, Communications Control, Operator Interface, Trend and History Files, Report Generator, and Support Utilities.
 - 1. Real time operating system shall be true multi-tasking providing concurrent execution of multiple real time programs and custom program development.
 - 2. Data Base manager is to manage data on an integrated and non-redundant basis. It shall allow additions and deletions to the data base without any detriment to the existing data.
- B. Operator Interface Software:
 - 1. Operator access to the system is to be under personal ID and password control for up to 100 unique operators.
 - 2. Up to 100 frequently addressed system points shall be definable as "quick access" points. Each points user address, descriptor, and value/status shall be displayed.
 - 3. Points (physical and pseudo) shall be displayed with dynamic data provided by the system with appropriate text descriptors, status or value, and engineering unit. Points shall be dynamic and shall continuously update anytime their field status/value changes.
 - 4. An on-line context-sensitive help utility shall be provided to facilitate operator training and understanding.
 - 5. Electronic messaging facility shall be provided on the operator station for any operator to enter a message to another operator.
- C. Site Specific Customizing Software:
 - 1. Provide software which will allow the user to modify and tailor the temperature control to the specific and unique requirements of the equipment installed, the programs implemented, and to staffing and operational practices.
 - 2. Point alarms shall be user-classifiable as critical or non-critical. Critical alarms shall be displayed in a dialog box of the color monitor. Display shall include time and date of occurrence, indication of alarm condition, analog value or status, user address, and alarm message.
 - 3. A discrete per point detailed alarm-action taking message of up to 480 characters shall be available for each point.
 - 4. Alarms shall be directed to the user selected alarm printer.
 - 5. Non-critical alarms shall only output to the printer and OS disk in order of occurrence.
 - 6. Run time limit messages shall be presented and processed as alarm messages except the action message shall be of a maintenance directive nature.
- D. Dynamic trends shall provide for each OS of up to eight user selected points to show real time activity of the associated points. This information shall be printed and/or displayed in numeric, bar chart, curve plot, pie chart, etc., as selected by the operator.
- E. Standard Reports Shall Be Provided Which Shall Be Output onto the Selected Report Printer. The Following Standard Pre-formatted Reports Shall Be Provided:

1. The user shall be provided with a command trace feature selectable on a per point basis allowing the archiving of commands issued to each point.
 2. A custom report capability shall be provided to allow the user to format reports of any mix of text, points with status/value and descriptors, and points with status/value only.
 3. Alarm history. The last 4000 alarm events shall be disk archived. Viewing or printing shall be by entering a date range (from-to).
 4. Operator activity. Operator activity shall be archived. Viewing or printing shall be by entering a desired date range.
 5. Trend reports shall allow the operator to randomly select point archival. Equipment controllers trend points (hardware and software) shall be assignable to PC archive files for display at user selectable intervals of 10 seconds to 24 hours.
- F. Equipment controllers shall be up-line or down-line loadable to or from the OS disk for backup archival.
- G. Provide software to execute and observe diagnostics of any remote device connected to the peer bus and the ability to deactivate and restart the device.
- H. In addition, a word processing utility, graphics package, and spreadsheet shall be available for generic use. The base system software shall include a CRT "windowing" feature to allow the operator to monitor the real time system and use third party software simultaneously.

2.12 GRAPHIC PROGRAMMING

- A. Graphic Programming. Provide hardware and software required for complete equipment controllers ATC programming of plant programs including plant system schematic development, I/O hardware point definition, hardware and software text point descriptors, ATC algorithmic development, a controller software loading utility, and a live programming test facility. At a minimum, the following shall be provided in the graphics package:
1. Exhaust fans- control and status
 2. Floor plans showing temperature sensors - control and status.
 3. Air handling units, rooftop HVAC units and associated pumps, fans, dampers - control and status.
- B. Provide a Boolean logic switching table matrix module for building ON-OFF commands from combinations of and or functions.
- C. Provide a program testing utility which allows live and dynamic monitoring of the graphically displayed control programs provided.
- D. In addition to training specified elsewhere in this Specification, provide 4 days of additional programming training, at a minimum of 4 hours training per day. These 4 days of additional training shall be provided during the 1 year warranty period. They are intended for use by the Owner as questions regarding system operation arise. Coordinate with the Owner.
- E. Provide two sets of programmer's manuals.

2.13 CONTROLLER SOFTWARE

- A. Energy Management application programs and associated data files shall be in non-volatile memory.

1. Optimum Start shall delay equipment start-up based on global outdoor temperature, space temperature, and system response to assure that comfort conditions are reached at scheduled occupancy. The optimum start program shall operate fully stand-alone in the local equipment controllers.
2. A load reset program shall be provided to assure that only the minimum amount of heating, cooling, and electrical energy is supplied to satisfy zone temperature requirements.

B. Control Software:

1. Each equipment controllers shall contain up to 20 unique user modifiable time programs.
2. Control Application Software shall be customized strictly to meet the detailed requirements of the "Sequence of Operation" specified hereinafter. Equipment controllers and terminal controllers shall be fully programmable. Initial software shall be fully modifiable, and not restricted by vendor's specific configuration guidelines. Equipment controllers control software shall be designed via a graphic programming facility, the detailed graphic design of which shall be provided as system documentation. Control strategies shall be advanced as noted with stabilizing setpoint ramps and procedures to assure slow loading of variable load equipment and economizer modes to prevent unsafe overshoot of controlled pressure and unsafe undershoot of mixed air temperatures during start-up and transition periods.

C. Management Software:

1. Each equipment controllers shall be provided with a trend archive of at least the last 200 events (digital transitions or analog value changes) of any user selected group of up to 20 points. A stored event shall include date and time, and value or status. Point events shall be displayable at local panels as trend logs for evaluation of control system performance.
2. Each equipment controllers shall monitor analog input points and specified digital points for off-normal conditions. Each alarm shall have an "alarm delay" attribute which shall determine how long (in seconds) a point must be in an off-normal state prior to being considered in an alarm state.

- D. Communications Software: Each equipment controllers shall have a full master peer-to-peer communications module to support global data sharing, hierarchical control, and global control strategies specified.

2.14 DATA COMMUNICATIONS

- A. Equipment controllers shall be interconnected via a primary communications network. Terminal controllers shall also be connected together via secondary networks to provide data concentration and parallel processing. Networks shall support sensor sharing, global application programs, and bus-to-bus communications without the presence of a host PC.
- B. The equipment controller's communications network shall support true peer protocol such that loss of any single device will not cause total bus failure.

2.15 GENERAL

- A. ATC setpoints, reset schedules, time programs, historical trends shall be displayable at local ATC panels and on the system's operator workstations.

2.16 SPARE POINTS

- A. Provide a minimum of 10% spare points or 16 spare points, whichever is greater, in each ATC control panel for future use. Spare points shall be equally distributed among analog input, analog output, digital input and digital output. It is not intended that spare points be provided in unitary control panels which serve VAV boxes, unit ventilators, fan coil units and heat pumps. It is intended that spare points be provided in master control panels and in panels which serve boiler/mechanical rooms and major equipment such as air handling units.

2.17 INSTALLATION

- A. Wiring and conduits shall be properly supported and run in a neat and workmanlike manner. Wiring and conduits exposed and in equipment rooms shall run parallel to or at right angles to the building structure. Wiring and conduits within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals.
- B. The ATC Contractor shall be responsible for electrical installation, including low voltage and line voltage wiring, required for a fully functional control system and not indicated on the Electrical Drawings or required by the Electrical Specifications. Wiring shall be in accordance with local and national codes. Control wiring in boiler room, mechanical room and equipment rooms shall be installed in conduit which shall comply with the requirements of the Electrical Specifications. Electronic wiring shall be #18 AWG minimum THHN and shielded if required.
- C. Provide power for normally-open [VAV-box and duct reheat coil] [fintube] [baseboard] hot water valves from a central source(s). Interlock with hot water pump(s) to deenergize valves when pump is deenergized.
- D. The ATC Contractor shall enter computer programs and data files into the related computers including control programs, initial approved parameters and settings, and English descriptors.
- E. The ATC Contractor shall maintain CD copies of data file and application software for reload use in the event of a system crash or memory failure. One copy shall be delivered to the Owner during training session, and one copy shall be archived in the ATC Contractor's local software vault.
- F. Adjustment/relocation of freezestats shall be performed by the ATC Contractor as required to eliminate nuisance freezestat alarms.
- G. Wall mounted temperature sensors shall be attached either to a wall stud or to blocking, or to an electrical wall box attached to such wall framing. Attaching to gypsum wallboard only shall not be allowed.
- H. Aquastats installed on unit heaters and at any location above 5'-0" (1525 mm) above finished floor shall be installed with adjustment knobs facing downward to facilitate adjustment.
- I. Outdoor air temperature sensor(s) shall be installed on the North side of the building.
- J. Thermostats and temperature sensors are indicated on the Drawings for general location. Terminal heat transfer units and fans which control space temperature shall be provided with thermostatic control, whether or not a thermostat or temperature sensor has been indicated on the Drawings.

2.18 VALIDATION

- A. The ATC Contractor shall completely check out, calibrate, and test connected hardware and software to insure that the system performs in accordance with the approved submittals for specifications and sequences of operations.
- B. Witnessed Validation Demonstration: Shall consist of:
 - 1. Display and demonstrate each type of data entry to show site specific customizing capability.
 - 2. Execute digital and analog commands.
 - 3. Demonstrate ATC loop precision and stability via trend logs of inputs and outputs.
 - 4. Demonstrate energy management performance via trend logs and command trace.

2.19 TRAINING

- A. Training shall be by the ATC Contractor and shall utilize specified manuals and as-built documentation.
- B. Operator training shall include 10 four-hour sessions encompassing:
 - 1. Modifying text.
 - 2. Sequence of Operation review.
 - 3. Selection of displays and reports.
 - 4. Use of specified functions.
 - 5. Setting and adjusting of occupancy schedules.
 - 6. Troubleshooting of sensors.
 - 7. Owner questions/concerns.
- C. Two training sessions shall be conducted at project substantial completion, and the others shall be conducted at the Owner's request and in accordance with the Owner's schedule within a period of 6 months after substantial completion of the project.
- D. At six months after substantial completion, unused training hours shall be, at the Owner's discretion, used for future training of new personnel or reimbursed to the Owner at the Contractor's current hourly service rate.

PART 3 - SEQUENCE OF OPERATION

3.1 GENERAL

- A. Setpoints shall be adjustable by the building operator through the graphic interface on the operator's workstation desktop PC, and through a portable laptop computer plugged into the system at locations throughout the building.
- B. Provide the ability for the Testing and Balancing Agent to connect to the system and change setpoints, to temporarily override setpoints, and to override modes of operation, as may be required for their work.

3.2 ALARMS

- A. Provide the capability to generate alarms, complete with individualized per point alarm message. Disable alarms when their associated system has been disabled as part of a standard control

function. For example, when hot water system is inactive during the summer months and hot water temperature drops below the low water temperature alarm set point, do not generate an alarm.

- B. Environmental Alarms: Provide a digital output point to deliver an environmental alarm signal to the building's security system. Provide digital output point and associated wiring to the security panel. Final connection to security panel shall be by Division 26 (coordinate with Division 26). The environmental alarm shall be a single point. The following alarm conditions shall activate the environmental alarm:
 - 1. Low temperature (below 50 deg F) at each room temperature sensor

3.3 HEATING MODE

- A. Heating Mode:
 - 1. Heating mode is automatically enabled when outside air temperature drops below setpoint (60°F, adjustable) or when there is a call for heating from the low-temperature alarm in any space. Heating mode is automatically disabled when the outside air temperature rises above setpoint.
 - 2. Heating control valves are powered from dedicated circuits. When the hot water pumps are disabled, control power to the valves is de-energized, allowing the valves to go to failsafe position. This is to prolong actuator life by turning them off in warm weather.
- B. Provide manual override points on the graphics screen to allow the Owner to override the automatic heating and cooling modes.
- C. Glycol Hot Water Circulating Pump (P-1)
 - 1. Pump is started and stopped through the stand alone DDC system on a call for heat from the ERV-1 heating coil. The pump runs continuously in heating mode.
- D. Steam Converter for Glycol Hot Water System (HX-1)
 - 1. Steam control valve modulates open through the stand alone DDC system on a call for heat from the ERV-1 heating coil. Steam control valve modulates closed through the stand alone DDC system when the ERV-1 heating coil is satisfied.
- E. Baseboard Radiation
 - 1. Space sensor: Tamper resistant, wall-mounted, blank cover, without setpoint dial or thermometer.
 - 2. Setpoint: Provide occupied/unoccupied control. Initial setpoints (adjustable).

3.4 FIRE ALARM SYSTEM SHUT-DOWN INTERFACE

- A. For starters that are associated with equipment that is required to be shut down upon a fire alarm condition, provide input contacts within the starter enclosure to interface with the building(s) fire alarm system. Upon receipt of a signal from the building(s) fire alarm system, power to load side of the starter is turned off. Circuitry is provided to ensure that power is off whether the starter is in the "AUTO", "HAND" or "BYPASS" mode. If this feature is not available from the starter manufacturer, provide a contactor on the line side of the starter to accomplish the same function. The contactor shall meet the requirements of Division 26.

3.5 RE-START PHASING AFTER POWER INTERRUPTION

- A. Upon a power interruption, a loss of power, or at morning start-up, equipment of electrical power greater than or equal to 1.0 HP is started in a staged manner which allows a time delay of 30 seconds between the start of each device.

3.6 VRF SYSTEM CONTROL SEQUENCES (Stand-alone control)

- A. Start and Stop Supply Fan(s): AC units with their associated heat recovery unit shall run continuously during occupied periods, and cycle on/off during unoccupied period to maintain space temperature setpoint.
- B. Temperature Control: Local wall-mounted space sensors connected to the system control panel will activate the heat recovery unit and evaporator serving that space.

3.7 ERV-1 CONTROL SEQUENCES

- A. Unit will be controlled via integral unit controls to operate continuously.
- B. Unit shall automatically cycle calling for glycol hot water heating and DX cooling to maintain constant discharge setpoint of 70 deg. F (adj.).
- C. Unit shall automatically control supply and exhaust fans to provide constant volume airflow.
- D. Unit shall automatically control energy recovery wheel.

END OF SECTION 230900

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SECTION 232113 – HYDRONIC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings For:
 - 1. Heating water piping system.
 - 2. Glycol water piping system.
 - 3. Equipment drains and overflows.
- B. Valves:
 - 1. Gate valves.
 - 2. Globe or angle valves.
 - 3. Ball valves.
 - 4. Check valves.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Access Doors.

1.3 RELATED SECTIONS

- A. Division 08 Section “Access Doors and Frames.”
- B. Division 09 Section for painting.
- C. Division 23 Section “Sleeves and Escutcheons for HVAC Piping.”
- D. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment.”
- E. Division 23 Section “Identification for HVAC Piping and Equipment.”
- F. Division 23 Section “HVAC Piping Insulation.”

1.4 REFERENCES

- A. ASME - Boiler and Pressure Vessel Codes, SEC 9 - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
- B. ASME B16.3 - Malleable Iron Threaded Fittings Class 50 and 300.
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- E. ASME B31.9 - Building Services Piping.
- F. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.
- G. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.

- H. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- I. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
- J. ASTM A312 - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
- K. ASTM A403 - Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
- L. ASTM B32 - Solder Metal.
- M. ASTM B88 - Seamless Copper Water Tube.
- N. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
- O. ASTM D1785 - Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- P. ASTM D2235 - Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
- Q. ASTM D2241 - Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series).
- R. ASTM D2466 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- S. ASTM D2467 - Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- T. ASTM D2680 - Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite-Sewer Piping.
- U. ASTM D2683 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
- V. ASTM D2855 - Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
- W. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- X. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- Y. ASTM F2389 - Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems
- Z. ASTM F845 - Plastic Insert Fittings for Polybutylene (PB) Tubing.
- AA. AWS A5.8 - Brazing Filler Metal.
- BB. AWS D1.1 - Structural Welding Code.
- CC. AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.

- DD. AWWA C110 - Ductile - Iron and Grey -Iron Fittings 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
 - EE. AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Grey-Iron Pressure Pipe and Fittings.
 - FF. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
 - GG. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
 - HH. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
 - II. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
 - JJ. NSF/ANSI 14 – Plastic Piping System Components and Related Materials.
- 1.5 SUBMITTALS
- A. Submit under provisions of Division 01 Section “Submittal Procedures.”
 - B. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide Manufacturers catalogue information. Indicate valve data and ratings.
 - C. Welders Certificate: Include welder’s certification of compliance with ASME SEC 9 and AWS D1.1.
 - D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- 1.6 PROJECT RECORD DOCUMENTS
- A. Submit under provisions of Division 01 Section “Closeout Procedures.”
 - B. Record actual locations of valves.
- 1.7 OPERATION AND MAINTENANCE DATA
- A. Submit under provisions of Division 01 Section “Operation and Maintenance Data.”
 - B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
- 1.8 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years’ experience.
 - B. Installer: Company specializing in performing the work of this Section with minimum 3 years’ experience.
 - C. Welders: Certify in accordance with ASME SEC 9 and AWS D1.1.

- D. Pressed Pipe Fittings: Submit documentation of fitting-manufacturer training of installers or their on-site supervisors, with names of individuals.

1.9 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 code for installation of piping system.
- B. Welding Materials and Procedures: Conform to ASME SEC 9 and applicable state labor regulations.
- C. Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01 Section "Product Requirements."
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 - PRODUCTS

2.1 HEATING WATER [AND GLYCOL] PIPING, ABOVE GROUND

- A. Steel Pipe: ASTM A53, Schedule 40 [for sizes less than 12 inch (300 mm), 0.375 inch (10 mm) wall for sizes 12 inch (300 mm) and over], black.
 - 1. Fittings: ASTM B16.3, malleable iron or ASTM A234, forged steel welding type fittings.
 - 2. Joints: Schedule 40 threaded for pipe sizes 2 inch (50.8 mm) and smaller, and AWS D1.1, welded for pipe sizes over 2 inch (50.8 mm).
 - 3. Grooved and Shouldered Pipe End Couplings: As specified in this Section, with grooved steel pipe, is an acceptable alternate to the above for water service operating at temperatures from -30 to 230 degrees F (-30 to 110 degrees C), utilizing grade E, EPDM gasket compound.
- B. Copper Tubing: ASTM B88, Type L hard drawn.
 - 1. Allowed only for pipe sizes 2 inch (50.8 mm) and smaller.
 - 2. Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.
 - 3. Joints: Solder or braze, or press fittings.

- C. Stainless Steel Pipe with Press Fittings: See paragraph titled “Press Fittings and Stainless Steel Piping Systems” in this Section.

2.2 EQUIPMENT DRAINS AND OVERFLOWS

- A. Steel Pipe: ASTM A53, Schedule 40 galvanized.
 - 1. Fittings: Galvanized cast iron, or ASTM B16.3 malleable iron.
 - 2. Joints: Threaded, or grooved mechanical couplings.
- B. Copper Tubing: ASTM B88, Type L, hard drawn.
 - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
 - 2. Joints: Solder or braze, or press fittings.

2.3 BRAZING MATERIALS – 15 percent Silver for copper, brass, and bronze

- A. Manufacturers:
 - 1. Harris (Product: Stay-Silv 15).
 - 2. Lucas-Milhaupt (Product: Sil-Fos 15).
 - 3. Wolverine (Product: Silvaloy 15).
 - 4. No substitutions.
- B. Nominal Composition: 5.0 percent phosphorus, 15.0 percent silver, 0.15 percent other elements (total), remainder copper. Cadmium-free.
- C. Physical Properties:
 - 1. Color: Yellow/Gray
 - 2. Solidus: 1190 degrees F (643 degrees C)
 - 3. Liquidus: 1480 degrees F (802 degrees C)
 - 4. Brazing Range: 1300 – 1500 degrees F (704-816 degrees C)
 - 5. Electrical Conductivity: 9.9 percent IACS
 - 6. Electrical Resistivity: 17.40 Microhm-cm
- D. Specification Compliance:
 - 1. ANSI/AWS A5.8, class BCuP-5
 - 2. ASME SFA5.8, class BCuP-5
 - 3. Optional:
 - a. QQB 650C, class BCuP-5
 - b. QQB 654A, class BCuP-5
 - c. QQB 654, class BCuP-5
- E. Flux:
 - 1. Harris (Stay-Silv For copper-to-brass joints. No flux required for copper-to-copper joints).

2.4 BRAZING MATERIALS – 35 percent Silver for brazing to ferrous metals (steel)

- A. Manufacturers:
 - 1. Harris (Product: Safety-Silv 35).
 - 2. Lucas-Milhaupt (Product: Braze 351).
 - 3. Wolverine (Product: Silvaloy A-35).
 - 4. No substitutions.

- B. Nominal Composition: 35.0 percent silver, 33 percent Zinc, 0.15 percent other elements (total), remainder copper. Cadmium-free.
- C. Physical Properties:
 - 1. Color: Yellow/Gray
 - 2. Solidus: 1250 degrees F (677 degrees C)
 - 3. Liquidus: 1410 degrees F (732 degrees C)
 - 4. Electrical Conductivity: 19.8 percent IACS
 - 5. Electrical Resistivity: 8.2 Microhm-cm
- D. Specification Compliance:
 - 1. ANSI/AWS A5.8, class BAg-5
 - 2. ASME SFA5.8, class BCuP-5
- E. Flux:
 - 1. Harris (Stay-Silv white flux, or where heating cycles are extended, Stay-Silv black flux).

2.5 SOLDER MATERIALS:

- A. Manufacturers:
 - 1. Harris (Product: Stay-Brite).
 - 2. Lucas-Milhaupt (Product: Clean 'n Brite).
 - 3. Wolverine (Product: Silvabrite).
 - 4. No substitutions.
- B. Nominal Composition: Alloy of silver and tin (3-6 percent Ag, remainder Sn). Antimony-free.
- C. Physical Properties:
 - 1. Color: Bright Silver
 - 2. Solidus: 430 degrees F (221 degrees C)
 - 3. Liquidus: 430 degrees F (221 degrees C)
 - 4. Electrical Conductivity: 16.4 percent IACS
 - 5. Shear Strength: 10,600 psi (73 MPa)
 - 6. Tensile Strength: 14,000 psi (96 MPa)
 - 7. Elongation: 48 percent
- D. Specification Compliance:
 - 1. NSF 51
 - 2. ASTM B32-89, Alloy Grade Sn96
 - 3. Federal Spec. QQ-S-571E, Class Sn 96 with exception to QPL paragraph 3.1
 - 4. J-STD-006, Sn96Ag04A
- E. Flux:
 - 1. Harris (Product: Stay Clean Paste Flux, Stay Clean Liquid Flux (used with 4 inch or larger copper tubing also stainless steels), or Bridgit Water Soluble Paste Flux).
 - 2. Canfield (Product: Aqua-Brite or AB Cream Flux). Glycerin-based, water soluble.

2.6 UNIONS, FLANGES, AND COUPLINGS

- A. Unions for Pipe 2 inch (50 mm) and Under:
 - 1. Ferrous Piping: 150 psig (1034 kPa) malleable iron, threaded.

2. Copper Pipe: Bronze, soldered joints.
3. Polypropylene Pipe:
 - a. Manufacturer: Aquatherm, Greenpipe product line, no substitutions.
 - b. Polypropylene with polypropylene nut or brass nut.
- B. Flanges for Pipe Over 2 Inch (50 mm):
 1. Ferrous Piping: 150 psig (1034 kPa) forged steel, slip-on.
 2. Copper Piping: Bronze.
 3. Polypropylene Pipe:
 - a. Manufacturer: Aquatherm, Greenpipe product line, no substitutions.
 4. Gaskets: 1/16 inch (1.6 mm) thick preformed neoprene or EPDM, reinforced as required for the system operating pressure, up to relief valve setting.
- C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.7 SLEEVES

- A. See Division 23 Section "Sleeves and Escutcheons for HVAC Piping."

2.8 VALVES

- A. Manufacturers:
 1. Nibco.
 2. Apollo.
 3. Armstrong.
 4. Crane.
 5. Hammond.
 6. Milwaukee.
 7. Watts.
 8. Wheatley.
 9. No substitutions.
- B. Gate Valves Over 2 inch (50 mm):
 1. Iron body, bronze trim, bolted bonnet, rising stem, handwheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends.
 2. 125 lb S.W.P., 200 lb W.O.G.
- C. Ball Valves:
 1. Up To and Including 2 inch (50 mm):
 - a. Bronze two piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle, solder or threaded ends.
 - b. 150 lb S.W.P., 600 lb W.O.G.
 2. Over 2 Inch (50 mm):
 - a. Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle, flanged.
 - b. 150 lb S.W.P., 285 lb W.O.G.
 3. PVC Piping:
 - a. PVC material for body, ball, and stem. Plastic handle. PTFE seats, EPDM seals.
 - b. Full port design through 4 inch (102 mm), tee or lever handle.
 - c. Working temperature 140 degrees F (60 degrees C).

- d. Drain Valves Up To and Including 1 inch (25 mm):
 - 1) Hayward QIC2 Series.
 - 2) Compact ball valve.
 - 3) Working pressure 150 psig (1034 kPa) WOG.
 - e. Valves 1/2 to 6 inch (12 to 152 mm):
 - 1) Hayward TB Series.
 - 2) True union ball valve. O-ring union seals.
 - 3) Blow-out proof stem, with double o-ring stem seals.
 - 4) Working pressure (socket or threaded) 230 psig (1585 kPa) WOG.
 - 5) Working pressure (flanged) 150 psig (1034 kPa) WOG.
4. Stem Extensions: Provide ball valves in insulated piping with stem extensions to allow for continuous thickness of field-installed insulation.
- D. Swing Check Valves:
- 1. Up To and Including 2 inch (50 mm): Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder or threaded ends.
 - 2. Over 2 inch (50 mm): Iron body, bronze trim, bronze or bronze faced rotating swing disc, renewable disc and seat, flanged ends.
- E. Spring Loaded Check Valves: Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer or threaded lug ends.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- E. After completion, fill, clean, and treat systems. Refer to Division 23 Section "HVAC Water Treatment."

3.2 INSTALLATION

- A. Install in accordance with Manufacturer's instructions.
- B. Install components furnished under other Section and Divisions of the Specifications. Such items may include but are not limited to: Sensors furnished under Division 23 Section "Instrumentation and Control for Mechanical Systems."
- C. Install heating water, glycol, piping to ASME B31.9.
- D. Pipe used shall be new material, and threads on piping shall be full length and clean cut with inside edges reamed smooth to full inside bore.

- E. Minimum pipe size allowed for hydronic piping shall be 3/4 inch (19 mm). Piping less than 3/4 inch (19 mm) shall not be allowed for these piping systems.
- F. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- G. Install piping to conserve building space, and not interfere with use of space.
- H. Group piping whenever practical at common elevations.
- I. Erect piping to provide for the easy passage and noiseless circulation of water under working conditions.
- J. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level. Slope water piping 1 inch in 40 feet (1:480) and arrange to drain at low points. Slope piping up in direction of water flow.
- K. On closed systems, equip low points with 3/4 inch (19 mm) drain valves and hose nipples. Provide, at high points of mains, collecting chambers and high capacity float operated automatic air vents, with ball valves on their inlets to valve off after initial system startup. Provide, at high points of branches, manual air vents with air chambers.
- L. Use main sized saddle type branch connections for directly connecting branch lines to mains in steel piping if main is at least 1 pipe size larger than the branch for up to 6 inch (152 mm) mains and if main is at least 2 pipe sizes larger than branch for 8 inch (203 mm) and larger mains. Do not project branch pipes inside the main pipe.
- M. Caulking of threads will not be allowed on any piping.
- N. Pipe joint compound shall be put on male threads only.
- O. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- P. Dissimilar Metals: Use non-conducting dielectric connections whenever jointing dissimilar metals. Cast red-brass (not yellow brass) or bronze-bodied fittings such as valves and couplings may be used when joining steel to copper, steel to stainless steel, or copper to stainless steel. Steel and stainless steel may connect directly to iron, but copper may not connect directly to iron.
- Q. Where welded joints are required, steel piping shall be installed by the use of the oxyacetylene or electric welding process, except immediate connections to accessible equipment may be threaded. Piping shall have butt welds with welding fittings, standard factory fabricated tees, elbows, reducers, caps, and accessories. Branch outlets 2 inch (50.8 mm) and smaller shall be made by the use of approved welding type half-couplings, "Weldolet" or "Threadolet" fittings.
 - 1. Piping smaller than 2 inch (50.8 mm) may be installed at the Contractor's option with welding type, or threaded type fittings, except that piping regardless of size concealed in trenches or inaccessible building construction (for example, concealed behind sheetrock walls or concealed above sheetrock ceilings) shall be welded.
 - 2. Offsets shall be installed with long radius welding elbows.

3. Welding shall be executed only by certified welding mechanics in accordance with the best practice of the trade.
- R. Sleeve pipe passing through partitions, walls and floors:
 1. See Division 23 Section "Sleeves and Escutcheons for HVAC Piping."
 - S. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Division 23 Section "HVAC Piping Insulation."
 - T. In the erection of mains, use special care in the support, working into place without springing or forcing, and proper allowance made for expansion.
 - U. Pipes shall be anchored, guided, and otherwise supported, where necessary, to prevent vibration or to control expansion.
 - V. Make such offsets as are shown and required to place the pipes and risers in proper position to avoid other work.
 - W. Take branch lines off bottom of mains or at 45 degree bottom angle, as space permits.
 - X. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
 - Y. Install a sufficient number of unions or flanged fittings to facilitate making possible future alterations or repairs.
 - Z. Install concealed pipes close to building structure to keep furring to a minimum.
 - AA. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Division 08 Section "Access Doors and Frames."
 - BB. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
 - CC. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Division 09 Section "Painting."
- 3.3 VALVES
- A. Valve Type Selection:
 1. Use gate or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
 2. Use globe or ball valves for throttling, bypass, or manual flow control services.
 3. Use N.R.S. Gate Valves for general shut-off service in heating system piping 2-1/2 inch (63.5 mm) and larger.
 4. Use Bronze Ball Valves for general shut-off service in heating system piping 2 inch (50.8 mm) and smaller and at heating terminal units 2 inch (50.8 mm) and smaller, including fin-tube radiation, unit heaters, convectors and fan coil units.

5. Use Combination Balancing, Flow Measuring and Tight Shut-off Valves at terminal heating and cooling units, zone branches and as indicated.
- B. With the exception of valves which must be properly sized to ensure design flow rates (such as balancing valves), valves shall be line sized.
- C. For isolation valves, control valves and balancing valves located above suspended ceilings and in areas that are not visible to building occupants (for example, mechanical rooms), provide yellow colored surveyors tape. Permanently attach tape to valve handles and run tape down to 10 inches (254 mm) above ceiling or 12 inches (305 mm) below valve handle where ceilings do not exist (for example, mechanical rooms).
- D. Standard details for heating and cooling coils are based on single coil arrangements. For heating and cooling coils that are supplied in a split coil arrangement, with 2 or more individual coils, provide additional piping and balancing valves at each coil to ensure that flow through each coil is proportional to the percentage of total coil face area that the coil occupies.
- E. Install valves with stems upright or horizontal, not inverted.

3.4 CLEANING

- A. After satisfactory completion of pressure tests, before permanently connecting equipment, strainers, and the like, clean equipment thoroughly, blow and flush piping for a sufficient length of time as directed, so that interiors will be free of foreign matter. Perform cleaning in the presence of an authorized representative of the Architect. Provide a minimum of 10 days notification to the Architect prior to system cleaning.
- B. Fill, vent and circulate the system with approved solution in accordance with equipment (boiler, piping, coils, and others) manufacturer's recommendation, allowing it to reach design or operating temperatures. After circulating for 6 hours, drain the system completely and remove and clean strainer screens. Perform cleaning in the presence of an authorized representative of the Architect. Provide a minimum of 10 days notification to the Architect prior to system cleaning.
- C. Fill and vent system as required.

3.5 TESTING

- A. No joint or section of piping shall be left untested.
- B. Before testing piping systems, remove, or otherwise protect from damage, control devices, air vents, and other parts which are not designed to stand test pressures.
- C. Test piping for leaks under 100 psig (689 kPa) air pressure with soap suds prior to hydrostatic testing.
- D. Test piping hydrostatically to 1-1/2 times the maximum systems operating pressure, but in no case to less than 75 psig (517 kPa), for at least 4 consecutive hours, during which time pressure shall remain constant without pumping.

- E. Test and obtain Architect's approval before painting, covering, or concealing piping, including swing joints.

END OF SECTION 232113

SECTION 232118 – HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Air vents.
- B. Air separators.
- C. Strainers.
- D. Expansion Tanks.
- E. Flow indicators, controls, meters.
- F. Combination Valve Assemblies.
- G. Relief valves.

1.2 RELATED SECTIONS

- A. Division 23 Section “Meters and Gauges for HVAC Piping”: Test Ports.
- B. Division 23 Section “Hydronic Piping.”
- C. Division 23 Section “HVAC Water Treatment.”

1.3 REFERENCES

- A. ASME - Boilers and Pressure Vessel Codes, SEC 8-D-Rules for Construction of Pressure Vessels.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures.”
- B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.
- C. Submit inspection certificates for pressure vessels from authority having jurisdiction.
- D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01 Section "Closeout Procedures."

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01.
- B. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01 Section "Product Requirements."
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 - PRODUCTS

2.1 AIR VENTS

- A. Manual Type: Short vertical sections of 2 inch (50 mm) diameter pipe to form air chamber, with 1/8 inch (3 mm) brass needle valve at top of chamber.
- B. Float Type:
 - 1. Manufacturers:
 - a. Bell & Gossett.
 - b. Taco.
 - 2. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
- C. Washer Type:
 - 1. Manufacturers:
 - a. Bell & Gossett.
 - b. Taco.

2. Brass with hydroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring loaded ball check valve.

2.2 AIR SEPARATORS

- A. In-line Combination Air Separators/Strainers:
 1. Manufacturers:
 - a. Taco.
 - b. Bell & Gossett.
 2. Steel, tested and stamped in accordance with ASME SEC 8-D; for 125 psig (860 kPa) operating pressure, tangential or vertically offset inlet and outlet connections, top fittings for air vent and expansion tank, bottom fitting for drain, with internal stainless steel air collector tube, and removable stainless steel strainer. Fittings 2-1/2-inch (64 mm) and under shall be NPT threaded, larger fittings shall be flanged. Primer paint finish.

2.3 STRAINERS

- A. Manufacturers:
 1. Sarco.
 2. Armstrong.
 3. Barnes and Jones.
 4. Bell & Gossett.
 5. Muesco.
 6. Sarco.
- B. Size 2 inch (50 mm) and Under: Screwed brass or iron body for 175 psig (1200 kPa) working pressure, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.
- C. Size 2-1/2 inch (65 mm) to 4 inch (100 mm): Flanged iron body for 175 psig (1200 kPa) working pressure, Y pattern with 3/64 inch (1.2 mm) stainless steel perforated screen.
- D. Size 5 inch (125 mm) and Larger: Flanged iron body for 175 psig (1200 kPa) working pressure, basket pattern with 1/8 inch (3.2 mm) stainless steel perforated screen.

2.4 EXPANSION TANKS, BLADDER TYPE

- A. Manufacturers:
 1. Taco.
 2. Bell & Gossett.
 3. Flo-Fab.
 4. John Wood.
 5. Watts.
 6. Wessels.
 7. Amtrol Therm-X-Trol ASME
- B. Construction: Welded steel, tested and stamped in accordance with ASME SEC 8-D; supplied with National Board Form U-1, rated for working pressure of 125 psig (860 kPa), with removable and replaceable flexible butyl or EPDM bladder, full or partial acceptance type as indicated on the Drawings, and integral steel support stand.

- C. Accessories: Schraeder-type air-charging fitting and protective heavy steel cap, drain fitting with plug, and field-furnished pressure gauge.

2.5 FLOW CONTROLS

- A. Manufacturers:
 - 1. Bell & Gossett.
 - 2. Armstrong.
 - 3. Taco.
 - 4. Watts.
- B. Construction: Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- C. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psig (24 kPa).
- D. Control Mechanism: Stainless steel or nickel plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring.
- E. Accessories: In-line strainer on inlet and ball valve on outlet.

2.6 BALANCING VALVES AND COMBINATION BALANCING/SHUT-OFF VALVES.

- A. Manufacturers:
 - 1. Bell & Gossett.
 - 2. Armstrong.
 - 3. Nexus Valve.
 - 4. Taco.
 - 5. Tour and Andersson.
 - 6. Watts.
- B. Valves shall conform to one of the following:
 - 1. Variable-Orifice Manual Balancing Valve: Cast iron or bronze, globe style, balance valve with handwheel with vernier type ring setting and memory stop, readout valves equipped with integral check valves and gasketed caps. Readout valves measure the pressure differential across the variable opening between valve plug and valve seat. Valve shall be designed for positive shut-off. Drain valve may be furnished with this valve, and if positioned properly may be substituted for the separate drain valve indicated.
- C. Size balancing valves to allow a reading of 2 to 5 ft wg (6 to 15 kPa) pressure drop at design flow rates. Submittals shall include a chart of valve selections, indicating room number, terminal heating device tag, flow rate, pressure drop, and differential pressure reading.
- D. Insulation: Valves may be furnished with prefabricated thermal insulation. Flame spread reading shall be 25 or less per ASTM E84. R-value shall be 4 hr-sq.ft- F/Btu or greater.

2.7 COMBINATION VALVE ASSEMBLIES

- A. Manufacturers:

1. Flow Design, Inc.
2. Nexus Valve.
3. Or approved equal.

B. Assemblies combining valves and accessories may be furnished in lieu of the individual components, provided that the components are in the arrangement indicated on the Drawings and conform to the individual Specifications. Examples include combinations of manual balancing valves, unions, pressure/temperature test ports, strainers, manual air vents, flexible hose connections, and shutoff valves.

2.8 FLOW METERS

A. Portable meter consisting of case containing one, 3 percent accuracy pressure gauge with 0-25 feet (0-75 kPa) pressure range for 250 psig (3450 kPa) maximum working pressure, color coded hoses for low and high pressure connections, and connectors suitable for connection to read-out valves. Meter shall be provided to the owner at project close-out.

2.9 AUTOMATIC COLD WATER FILL ASSEMBLY

A. Manufacturers:

1. Taco.
2. Bell & Gossett.
3. Spence.
4. Watts.

B. Assembly: Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

C. Set pressure reducing valve to achieve 5 psi gauge pressure at high point of system. Provide pressure gauge at high point of system. Set pressure reducing valve when the temperature of the water in the system is less than 80 degrees F.

2.10 RELIEF VALVES

A. Manufacturers:

1. Bell & Gossett.
2. Cash Acme.
3. Spence.
4. Taco.
5. Watts.

B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Where large air quantities can accumulate, provide enlarged air collection standpipes.
- C. Provide manual air vents at system high points and as indicated.
- D. Provide air separator on suction side of system circulation pump and connect to expansion tanks.
- E. Provide valved drain and hose connection on strainer blow down connection.
- F. Ensure that balancing valves are installed with minimum upstream length of straight pipe as recommended by the manufacturer.
- G. Ensure that balancing valves are installed with the readout valves fully accessible, including space required for insertion of metering probes.
- H. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.
- I. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to not exceed maximum pressure rating of connected equipment.
- J. Pipe relief valve outlet to nearest floor drain.
- K. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.
- L. Pipe expansion tanks using heat traps to prevent heating of tanks.
- M. Expansion Tanks (Bladder and Diaphragm Type): Provide pressure gauge per Division 23 Section "Meters and Gauges for HVAC Piping" near point where expansion tank is connected to system, for determining required pre-charge pressure for air side of expansion tank. Isolate expansion tank from system and pre-charge air side of tank to same pressure as static head of system at point where expansion tank is connected to system. Measure static head of system after pressure reducing valve at cold water make-up has been properly set in accordance with this Section. Pre-charge air side of expansion tank only when the temperature of the water in the system is less than 80 degrees F (27 degrees C). Provide drain valve with hose end connection at point of connection to expansion tank to allow for periodic removal of system pressure in order to check expansion tank's pre-charge air pressure. Drain valve shall be located closest to expansion tank, isolation valve shall be immediately upstream of drain valve and pressure gauge shall be within sight upstream of isolation valve.

END OF SECTION 232118

SECTION 232123 – HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. In-line circulators.

1.2 RELATED SECTIONS

- A. Division 23 Section “Motors, Drives and Accessories.”
- B. Division 23 Section “HVAC Piping Insulation.”
- C. Division 23 Section “Hydronic Piping.”
- D. Division 23 Section “Hydronic Specialties”
- E. Division 26 “Electrical” Electrical characteristics and wiring connections.

1.3 REFERENCES

- A. UL 778 - Motor Operated Water Pumps.
- B. NFPA 70 - National Electrical Code.

1.4 PERFORMANCE REQUIREMENTS

- A. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading throughout the entire operating range in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

1.5 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures.”
- B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.
- D. Millwright's Certificate: Certify that base mounted pumps have been aligned.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01.

- B. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing, assembly, and field performance of pumps with minimum 3 years' experience.
- B. Alignment: Base mounted pumps shall be aligned by a qualified millwright.

1.8 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In-Line Circulators with Integral Speed Controller:
 1. Grundfos.
 2. Bell & Gossett.
 3. Taco
 4. No Substitutions.

2.2 GENERAL

- A. Statically and dynamically balance rotating parts.
- B. Construction shall permit complete servicing without breaking piping or motor connections.
- C. Pumps shall operate at 1750 rpm unless indicated or specified otherwise.
- D. Pump connections shall be flanged.
- E. Wetted parts shall be compatible with circulated fluid.

2.3 CARTRIDGE CIRCULATORS

- A. Type: Cartridge type circulator, in-line mounting, for 125 psig (862 kPa) maximum working pressure, 230 degrees F (110 degrees C) maximum water temperature.
- B. Casing: Cast iron with flanged pump connections.
- C. Impeller: Non-Metallic
- D. Shaft: Ceramic

- E. Bearings: Carbon.
- F. Motor: Impedance protected, single speed, permanent split capacitor.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.
- C. Decrease piping from line size with long radius reducing elbows or reducers.
- D. Pump inlet conditions shall be as recommended by the pump manufacturer to eliminate system effects.
 - 1. Provide suction diffusers where indicated. Suction diffusers shall have adequate space provided for strainer removal. Remove fine-mesh start-up strainers after system startup, and hang adjacent to the pump for Architect/Engineer's approval.
 - 2. Where suction diffusers are not indicated, provide proper straight lengths of inlet piping and long-radius elbows at pump inlets.
- E. Support piping adjacent to pump such that no weight is carried on pump casings. Provide necessary brackets or hanger supports as required to relieve the stress on the pumps and piping. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches (102 mm) and over.
- F. Provide line sized shut-off valve and strainer on pump suction, and properly sized soft seat check valve and balancing/flow-measuring/shutoff valve on pump discharge.
- G. Install pumps with a pressure gauge piped to suction and discharge, with shutoff valves.
- H. Provide air cock and drain connections on horizontal pump casings.
- I. Provide drains for bases and seals, piped to and discharging into floor drains with air gaps.
- J. Lubricate pumps before start-up.
- K. Provide labor and materials required to ensure that pump impellers are adequately sized to provide flow rates as indicated. This shall include, but not be limited to, trimming impellers.

END OF SECTION 232123

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SECTION 232213 – STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and pipe fittings.
- B. Valves.
- C. Steam piping system.
- D. Steam condensate piping system.

1.2 RELATED SECTIONS

- A. Division 23 Section “Identification for HVAC Piping and Equipment.”
- B. Division 23 Section “HVAC Piping Insulation.”
- C. Division 23 Section “HVAC Water Treatment”: Pipe cleaning.

1.3 REFERENCES

- A. ASME - Boiler and Pressure Vessel Codes, SEC 9 - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
- B. ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- E. ASME B31.1 - Code for Power Piping.
- F. ASME B31.9 - Building Services Piping.
- G. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- H. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- I. ASTM B32 - Solder Metal.
- J. ASTM B88 - Seamless Copper Water Tube.
- K. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- L. AWS A5.8 - Brazing Filler Metal.

- M. AWS D1.1 - Structural Welding Code.
- N. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
- O. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
- P. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.4 SYSTEM DESCRIPTION

- A. When more than 1 piping system material is selected, ensure systems components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.
- B. Use unions, flanges, and downstream of valves and at equipment or apparatus connections. Use dielectric unions where joining dissimilar materials. Do not use direct welded or threaded connections.
- C. Provide pipe hangers and supports in accordance with ASTM B31.9 and MSS SP69 unless indicated otherwise.
- D. Use ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- E. Use ball valves for throttling, bypass, or manual flow control services.

1.5 SUBMITTALS

- A. Submit under provisions of Division 01 Section "Submittal Procedures."
- B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
- C. Welders Certificate: Include welders certification of compliance with ASME/SEC 9 and AWS D1.1.
- D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.6 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01 Section "Closeout Procedures."
- B. Record actual locations of valves.

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01.
- B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum 3 years' experience.
- B. Installer: Company specializing in performing the work of this Section with minimum 3 years' experience.
- C. Welders: Certify in accordance with ASME SEC 9 and AWS D1.1.

1.9 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 and ASME B31.1 code for installation of piping system.
- B. Provide certificate of compliance from authority having jurisdiction indicating approval of welders.
- C. Welding Materials and Procedures: Conform to ASME SEC 9 and applicable State labor regulations.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01 Section "Product Requirements."
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 - PRODUCTS

2.1 PIPING GENERAL REQUIREMENTS

- A. Nominal wall thickness of pipe fittings shall equal or exceed nominal wall thickness of piping.

2.2 HIGH PRESSURE STEAM PIPING (150 PSIG (1034 kPa) MAXIMUM)

- A. Steel Pipe: ASTM A53, Schedule 40 for all sizes, black.
 - 1. Fittings: ASTM B16.3 malleable iron Class 250, or ASTM A234 forged steel welding type, Class 300.
 - 2. Joints: Threaded, or AWS D1.1 welded.

2.3 MEDIUM PRESSURE STEAM PIPING (75 PSIG (517 kPa) MAXIMUM)

- A. Steel Pipe: ASTM A53, Schedule 40 for all sizes, black.
 - 1. Fittings: ASTM B16.3 malleable iron Class 125, or ASTM A234 forged steel, Class 125.
 - 2. Joints: Threaded, or AWS D1.1 welded.

2.4 LOW PRESSURE STEAM PIPING (30 PSIG (207 kPa) MAXIMUM)

- A. Steel Pipe: ASTM A53, Schedule 40 for all sizes, black.
 - 1. Fittings: ASTM B16.3 malleable iron Class 125, or ASTM A234 forged steel Class 125.
 - 2. Joints: Threaded, or AWS D1.1, welded.

2.5 MEDIUM AND HIGH PRESSURE STEAM CONDENSATE PIPING

- A. Steel Pipe: ASTM A53, Schedule 80 for all sizes, black.
 - 1. Fittings: ASTM B16.3 malleable iron Class 125, or ASTM A234 forged steel Class 125.
 - 2. Joints: Threaded, or AWS D1.1, welded.

2.6 LOW PRESSURE STEAM CONDENSATE PIPING

- A. Steel Pipe: ASTM A53, Schedule 80 for all sizes, black.
 - 1. Fittings: ASTM B16.3 malleable iron Class 125, or ASTM A234 forged steel Class 125.
 - 2. Joints: Threaded, or AWS D1.1, welded.

2.7 PIPE HANGERS AND SUPPORTS

- A. Approved Manufacturers (first manufacturer is basis of design):
 - 1. Strut Hangers:
 - a. Unistrut (division of Tyco).
 - b. Anvil International.
 - c. Cooper B-Line.
 - d. Hydra-Zorb Company.
 - e. Thomas & Betts - Superstrut line.
 - f. Tolco (division of Nibco).
 - 2. Adjustable Swivel Band Hangers:
 - a. Carpenter & Paterson.
 - b. Anvil International.
 - c. Cooper B-Line.
 - d. Tolco (division of Nibco).
 - 3. Clevis Hangers:
 - a. Carpenter & Paterson.
 - b. Anvil International.
 - c. Cooper B-Line.
 - d. Tolco (division of Nibco).
 - 4. J-Hangers:
 - a. Carpenter & Paterson.
 - b. Cooper B-Line.
 - c. Thomas & Betts - Superstrut line.
 - d. Tolco (division of Nibco).

- e. Unistrut (division of Tyco).
 - 5. Roof Support Blocks/Non-Penetrating Roof-Mounted Pipe Support System:
 - a. Cooper B-Line - Dura-Blok line.
 - b. Miro Industries.
 - c. Unistrut (division of Tyco) - Unipier line.
 - 6. No substitutions.
- B. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69, and MSS SP89.
- C. Hangers for Pipe Sizes 1/2 to 1-1/2 inch (13 to 38 mm): Malleable iron or carbon steel, adjustable swivel, split ring.
- D. Hangers for Pipe Sizes 2 to 4 inches (50 to 100 mm): Carbon steel, adjustable, clevis.
- E. Hangers for Pipe Sizes 5 inches (150 mm) and Over: Adjustable steel yoke, cast iron roll, double hanger.
- F. Multiple or Trapeze Hangers for Pipe Sizes to 4 inches (100 mm): Steel channels with welded spacers and hanger rods.
- G. Multiple or Trapeze Hangers for Pipe Sizes 5 inches (150 mm) and Over: Steel channels with welded spacers and hanger rods; cast iron roll and stand.
- H. Wall Support for Pipe Sizes to 3 inches (70 mm): Cast iron hook.
- I. Wall Support for Pipe Sizes to 4 inches (100 mm): Welded steel bracket and wrought steel clamp.
- J. Wall Support for Pipe Sizes 5 inches (125 mm) and Over: Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll.
- K. Vertical Support: Steel riser clamp.
- L. Floor Support for Pipe Sizes to 4 inches (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- M. Floor Support for Pipe Sizes 5 inches (125 mm) and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
- N. Hanger Rods: Mild steel threaded both ends, threaded 1 end, or continuous threaded.
- O. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
- 2.8 UNIONS, FLANGES, AND COUPLINGS
- A. Unions for Pipe 2 inches (50 mm) and Under:
- 1. Ferrous Piping: 150 psig (1034 kPa) malleable iron, threaded.
 - 2. Copper Pipe: Bronze, soldered joints.

- B. Flanges for Pipe Over 2 inches (50 mm):
 - 1. Ferrous Piping: 150 psig (1034 kPa) forged steel, slip-on.
 - 2. Copper Piping: Bronze.
 - 3. Gaskets: 1/16 inch (1.6 mm) thick preformed non-asbestos graphite fiber.
- C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.9 VALVES

- A. Manufacturers:
 - 1. Nibco.
 - 2. Apollo.
 - 3. Crane.
 - 4. Milwaukee.

2.10 GATE VALVES

- A. Up To and Including 1-1/2 inches (40 mm):
 - 1. Bronze body, bronze trim, screw-in or union bonnet, rising stem, sold wedge disc, threaded ends.
 - 2. Class 150, 150 psig (10.3 bar) saturated steam S.W.P., 300 psig (20.7 bar) W.O.G.
- B. Over 1-1/2 inches (40 mm):
 - 1. Iron body, bronze trim, bolted bonnet, rising stem, outside screw and yoke, solid wedge disc with bronze seat rings, handwheel, flanged ends.
 - 2. Class 125, 125 psig (8.6 bar) saturated steam S.W.P., 200 psig (13.8 bar) W.O.G.

2.11 BALL VALVES

- A. Up To and Including 2 inches (50 mm):
 - 1. Bronze 2-piece body, chrome plated brass ball, teflon seats and stuffing box ring, blowout-proof stem, lever handle with balancing stops, solder or threaded ends.
 - 2. 150 psig (10.3 bar) saturated steam S.W.P., 400 psig (27.6 bar) W.O.G.
- B. Over 2 inches (50 mm):
 - 1. Cast steel body, chrome plated steel or stainless steel ball, teflon seat and stuffing box seals, blowout-proof stem, lever handle, flanged.
 - 2. Class 150, 150 psig (10.3 bar) saturated steam S.W.P., 285 psig (19.7 bar) W.O.G.
- C. Stem Extensions: Provide ball valves in insulated piping with stem extensions to allow for continuous thickness of field-installed insulation.

2.12 SWING CHECK VALVES

- A. Up To and Including 2 Inches (50 mm): Bronze body, bronze trim, bronze rotating swing disc with composition seat disc, regrinding type, renewable seat and disc, solder or threaded ends.
 - 1. Class 150, 150 psig (10.3 bar) saturated steam S.W.P., 300 psig (20.7 bar) W.O.G.

- B. Over 2 inches (50 mm): Iron body, bronze trim, bolted bonnet, bronze or bronze faced rotating swing disc, renewable disc and seat, flanged ends.
 - 1. Class 125, 125 psig (8.6 bar) saturated steam S.W.P., 200 psig (13.8 bar) W.O.G.

2.13 SLEEVES

- A. Pipes Through Floors: Form with 16 gage galvanized steel.
- B. Pipes Through Beams, Interior Walls, Fireproofing, Potentially Wet Floor: Form with steel pipe or 16 gage galvanized steel unless indicated otherwise on Drawings.
- C. Pipes Through Exterior Building Walls, Concrete Walls or Footing: Form with Schedule 40 (galvanized) steel pipe.
- D. Size large enough to allow for movement due to expansion and to provide for continuous insulation and firestopping.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction, protect open ends with temporary plugs or caps.
- E. After completion, fill, clean, and treat systems. Refer to Division 23 Section "HVAC Water Treatment."

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and not interfere with use of space.
- D. Sleeve pipe passing through partitions, walls, and floors.
 - 1. Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.
 - 2. Extend sleeves through potentially wet floors 1 inch (25 mm) above finished floor level. Caulk sleeves full depth and provide floor plate.
 - 3. Where piping passes through floor, ceiling or wall, close off space between pipe and construction with non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.

4. Install chrome-plated escutcheons where piping passes through finished surfaces.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Inserts:
1. Provide inserts for placement in concrete formwork.
 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches (100 mm).
 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.
- G. Pipe Hangers and Supports:
1. Install in accordance with ASTM B31.9, ASTM F708 and MSS SP89.
 2. Support horizontal piping as scheduled.
 3. Place hangers within 12 inches (300 mm) of each horizontal elbow.
 4. Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 7. Prime coat exposed steel hangers and supports. Refer to Division 09. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- H. Provide clearance for installation of insulation and access to valves and fittings.
- I. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Division 23.
- J. Slope steam piping 1 inch in 40 feet (0.25 percent). Slope piping down in direction of flow. Use eccentric reducers to maintain bottom of pipe level.
- K. Slope steam condensate piping 1 inch in 40 feet (0.25 percent). Provide drip trap assembly at low points and before control valves. Run condensate lines from trap to nearest condensate receiver. Provide loop vents over trapped sections.
- L. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply 1 coat of zinc rich primer to welds.
- M. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting.
- N. Install valves with stems upright or horizontal, not inverted.
- O. Where more than 1 piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide

necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

- P. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- Q. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.
- R. Valve Type Selection:
 - 1. Use gate or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
 - 2. Use ball valves for bypass, or manual flow control services.
 - 3. Use OS&Y Gate Valves at boiler supply and return connection in accordance to the applicable State Boiler Rules and Regulations.
 - 4. Use N.R.S. gate valves for general shut-off service in heating system piping 2-1/2 inches (63.5 mm) and larger.
 - 5. Use bronze ball valves 2 inches (50.8 mm) and smaller for general shut-off service in heating system piping 2 inches (50.8 mm) and smaller and at heating terminal units including fin-tube radiation, unit heaters, convectors and fan coil units.
 - 6. Use gate valves for throttling in steam systems in sizes 8 inches (203 mm) and larger.
- S. With the exception of valves which must be properly sized to ensure design flow rates and pressure drops (such as control valves), valves shall be line sized.
- T. For valves located more than 7 feet (2.1 m) above finished floor in equipment room areas, provide chain operated sheaves. Extend chains to 5 feet (1.5 m) above finished floor and hook to clips arranged to clear walking aisles. This applies to valves of types which can accept chain operators.
- U. Install concealed pipes close to building structure to keep furring to a minimum.
- V. Use main sized saddle type branch connections for directly connecting branch lines to mains in steel piping if main is at least 1 pipe size larger than the branch for up to 6 in. (152 mm) mains, and if main is at least 2 pipe sizes larger than branch for 8 inches (203 mm) and larger mains. Do not project branch pipes inside the main pipe.
- W. Use flanged fittings only in accessible locations.
- X. Make connections to equipment and branch mains with unions.
- Y. Pipe used shall be new material, and threads on piping shall be full length and clean cut with inside edges reamed smooth to full inside bore.
- Z. Caulking of threads will not be allowed on any piping.
- AA. Pipe joint compound shall be put on male threads only.
- BB. In the erection of mains, use special care in the support, working into place without springing or forcing, and make proper allowance for expansion.

- CC. Anchor, guide, and otherwise support piping, where necessary, to prevent vibration or to control expansion.
- DD. Make such offsets as are indicated and required to place the pipes and risers in proper position to avoid other work.
- EE. Install a sufficient number of unions or flanged fittings to make future alterations or repairs possible.
- FF. Erect piping to provide for the easy passage and noiseless circulation of fluids under working conditions.
- GG. Install steel piping by the use of the oxyacetylene or electric welding process, except immediate connections to accessible equipment may be threaded. Piping shall have butt welds with welding fittings, standard factory fabricated tees, elbows, reducers, caps, and accessories. Branch outlets 2 inches (50.8 mm) and smaller shall be made by the use of approved welding type half-couplings, "Weldolet" or "Threadolet" fittings.
 - 1. Piping smaller than 2-1/2 inches (63.5 mm) may be installed at the Contractor's option with welding type, or threaded type fittings, except that piping regardless of size concealed in trenches or building construction upon completion of building construction shall be welded.
 - 2. Offsets shall be installed with long radius welding elbows.
 - 3. Welding shall be executed only by certified welding mechanics in accordance with the best practice of the trade.
- HH. Piping Installation for Steam and Condensate Systems:
 - 1. Take steam supply branches off top of main, either vertically or at a 45 degree angle, as space permits.
 - 2. Provide drip points in steam lines at ends of mains, at points where rise in pipe elevation is required, where necessary to free steam lines from water and where indicated. Each trap used as end of main drip shall have gate valve and Y-type strainer.
 - 3. Provide dirt pocket and trap at bottom of steam risers and at each drip point. Dirt pockets on branch runouts shall be full size of branch. Dirt pockets on mains 3 inches (76.2 mm) and smaller shall be 1-1/4 inch (31.8 mm) size. Dirt pockets on larger mains shall be 2 inch (50.8 mm).
 - 4. Condensate from new piping shall be wasted until condensate is clean and only then shall condensate be returned to the system.

3.3 CLEANING

- A. Initially, remove the thermostatic elements from traps and the baskets from strainers and relief valves; open valves, including automatic control valves, and flush the system with water. To ensure entire system will be flushed, valve off the low pressure traps nearest the boilers during the flushing period, then working to the most remote trap, close off intermediate traps. As traps are closed, remove bottom drain plugs to drain the trap bodies; then replace plugs, thermostatic elements and strainers. This procedure is intended to rid systems of loose debris. To conclude the procedure, open valves at trap assemblies.

3.4 TESTING

- A. No joint or section of piping shall be left untested.
- B. Before testing piping systems, remove, or otherwise protect from damage, control devices and other parts which are not designed to withstand test pressures.
- C. Test piping for leaks under 100 psig (690 kPa) air pressure with soap suds before performing the hydrostatic test.
- D. Test piping hydrostatically to 1.5 times the maximum systems operating pressure, but in no case to less than 75 psig (517 kPa), for at least 4 consecutive hours, during which time pressure shall remain constant without pumping. Subject welded joints to hammer test while under hydrostatic pressure.
- E. Test and obtain Architect's approval before painting, covering, or concealing piping, including swing joints.

3.5 SCHEDULES

- A. Pipe Hanger Spacing:

PIPE SIZE		HANGER ROD MAX. HANGER SPACING		HANGER ROD DIAMETER	
Inches	(mm)	Feet	(m)	Inches	(mm)
1/2 to 1-1/4	12 to 32	6.5	2	3/8	9
1-1/2 to 2	38 to 50	10	3	3/8	9
2-1/2 to 3	62 to 75	10	3	1/2	13
4 to 6	100 to 150	10	3	5/8	15
8 to 12	200 to 300	14	4.25	7/8	22
14 and over	350 and over	20	6	1	25

END OF SECTION 232213

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SECTION 232218 – STEAM AND CONDENSATE HEATING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Steam traps.
- B. Steam air vents.
- C. Pressure reducing valves.
- D. Backpressure regulating valves.
- E. Steam safety valves.
- F. Strainers.

1.2 RELATED SECTIONS

- A. Division 23 Section “Motors, Drives, and Accessories.”
- B. Division 23 Section “HVAC Piping Insulation.”
- C. Division 23 Section “Steam and Condensate Heating Piping.”
- D. Division 26 Section “Equipment Wiring”: Electrical characteristics and wiring connections.

1.3 REFERENCES

- A. ASME - Boiler and Pressure Vessel Codes, SEC 8-D - Rules for Construction of Pressure Vessels.
- B. ASME B31.9 - Building Services Piping.
- C. ASTM A105 - Forgings, Carbon Steel, for Piping Components.
- D. ASTM A126 - Grey Iron Castings for Valves, Flanges, and Pipe Fittings.
- E. ASTM A216 - Steel Casings, Carbon, Suitable for Fusion Welding, for High Temperature Service.
- F. ASTM A395 - Ferric Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
- G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volt Maximum).
- H. NFPA 70 - National Electrical Code.

1.4 SYSTEM DESCRIPTION

- A. Follow these guidelines unless otherwise indicated.
- B. Use Float and Thermostatic Traps for:
 - 1. Humidifiers.
 - 2. Flash tanks.
 - 3. Steam fired domestic water heater.
 - 4. Autoclave.
 - 5. Main headers.
 - 6. Branch lines.
- C. Use Inverted Bucket Steam Traps for:
 - 1. Main headers.
 - 2. Branch lines.

1.5 PERFORMANCE REQUIREMENTS

- A. Steam Traps:
 - 1. Select to handle minimum of 2 times maximum condensate load of apparatus served.
 - 2. Where 2 traps are indicated on a coil or other equipment, select each for the full equipment condensate load.
 - 3. Pressure Differentials:
 - a. Low Pressure Systems (5 psi (34 kPa) and less): 1/2 psi (3.4 kPa).
 - b. Low Pressure Systems (15 psi (103 kPa) maximum): 2 psi (13.8 kPa).
 - c. Medium Pressure Steam (25 psi (172 kPa) maximum): 5 psi (34 kPa).
 - d. Medium Pressure Steam (40 psi (276 kPa) maximum): 10 psi (69 kPa).
 - e. Medium Pressure Steam (60 psi (414 kPa) maximum): 15 psi (103 kPa).
 - f. High Pressure Steam (100 psi (689 kPa) maximum): 30 psi (206 kPa).
 - g. High Pressure Steam (150 psi (1034 kPa) maximum): 40 psi (276 kPa).

1.6 SUBMITTALS

- A. Submit under provisions of Division 01 Section "Submittal Procedures."
- B. Product Data:
 - 1. Provide for manufactured products and assemblies required for this project.
 - 2. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
 - 3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each specialty.
 - 4. Include electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Indicate application, selection, and hookup configuration. Include pipe and accessory elevations.

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01.

- B. Operation and Maintenance Data: Include installation instructions, servicing requirements, and recommended spare parts lists.

1.8 QUALITY ASSURANCE

- A. Perform Work in accordance with State and Municipality standards for installation of boilers and pressure vessels.
- B. Maintain 1 copy of each standards document on site.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum 3 years' experience.

1.10 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 code for installation of steam and steam condensate piping and specialties.
- B. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose indicated.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01 Section "Product Requirements."
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.12 EXTRA MATERIALS

- A. Furnish under provisions of Division 01 Section "Closeout Procedures."
- B. Provide 2 service kits for each size and type of steam trap.
- C. Provide 1 set of mechanical seals for each pump.

PART 2 - PRODUCTS

2.1 INVERTED BUCKET TRAPS

- A. Manufacturers:
 - 1. Armstrong International.
 - 2. No substitutions.
- B. Trap:
 - 1. Construction: ASTM A126 Cast iron body, [forged steel or stainless steel] with bolted cover, brass or stainless steel bucket, stainless steel seats and plungers, and stainless steel lever mechanism with knife edge operating surfaces.
- C. Rating: 250 psig (1720 kPa) shell design pressure up to 450 degrees F (232 degrees C). Select operating differential pressure and orifice size as appropriate for system pressure.
- D. Features: Access to internal parts without disturbing piping, bottom drain plugs.
- E. Accessories: Provide integral bimetal air vent for quick startup, set to close at approximately 200 degrees F (93 degrees C).

2.2 FLOAT AND THERMOSTATIC TRAPS

- A. Manufacturers:
 - 1. Armstrong International.
 - 2. No substitutions.
- B. Trap:
 - 1. Construction: ASTM A126 cast iron, [cast steel] or stainless steel body and bolted cover, stainless steel or bronze bellows type air vent, stainless steel float, stainless steel lever and valve assembly.
 - 2. Rating: 125 psig (860 kPa) shell design pressure up to 450 degrees F (232 degrees C). Select operating differential pressure and orifice size as appropriate for system pressure.
 - 3. Features: Access to internal parts without disturbing piping, bottom drain plug.

2.3 STEAM AIR VENTS

- A. 125 psig (860 kPa) WSP:
 - 1. Manufacturers:
 - a. Armstrong International.
 - b. No substitutions.
 - 2. Balanced Pressure Type: Model T202, cast brass body and cover; access to internal parts without disturbing piping; stainless steel bellows, stainless steel valve and seat.
- B. 225 psig (1550 kPa) WSP:
 - 1. Manufacturers:
 - a. Armstrong International.
 - b. No substitutions.

2. Balanced Pressure Type: Series VS200, ASTM A126 cast iron body and cover; access to internal parts without disturbing piping; phosphor bronze bellows, stainless steel valve and seat.

2.4 STEAM VACUUM BREAKERS

- A. Manufacturers:
 1. Armstrong International.
 2. No substitutions.
- B. Cast brass or stainless steel body and cover, stainless steel valve and seat; threaded inlet and outlet; access to inspect internal parts without disturbing piping; for 210 psig (1445 kPa) up to 500 degrees F (260 degrees C); venting 4 CFM (1.8 L/s) standard air at 6 in. Hg (20.3 kPa) vacuum.

2.5 PRESSURE REDUCING VALVES

- A. Manufacturers:
 1. Spence.
 2. No substitutions.
- B. Bronze or cast iron body, stainless or chrome steel valve spring, stem, and trim, phosphor bronze diaphragm, direct acting, pilot operated, threaded up to 2 inches (50 mm), flanged over 2 inches (50 mm).

2.6 BACKPRESSURE REGULATING VALVES

- A. Manufacturers:
 1. Spence.
 2. No substitutions.
- B. Model 25BP, Bronze or cast iron body, stainless or chrome steel valve spring, stem, and trim, phosphor bronze diaphragm, pilot operated, threaded up to 2 inches (50 mm), flanged over 2 inches (50 mm). Designed to maintain a constant upstream pressure, with reverse-acting pressure pilot which opens the main valve when the sensed upstream pressure increases. Rated operating pressure 125 psig (862 kPa) at 450 degrees F (232 degrees C). Color-coded pilot valve spring in appropriate range, yellow, 3 to 30 psi (20.7 to 207 kPa).

2.7 SAFETY RELIEF VALVES

- A. Manufacturers:
 1. Spence.
 2. No substitutions.
- B. Valve: Bronze Body, stainless steel valve spring, stem and trim, pop action, direct pressure actuated capacities ASME certified and labeled.
- C. Accessories: Drip pan elbow.

2.8 STRAINERS

- A. Manufacturers:
 - 1. Armstrong.
 - 2. Bell & Gossett – a division of Xylem.
 - 3. Keckley Co.
 - 4. Watson McDaniel.
 - 5. Wheatley.
- B. Size 2 inch (50 mm) and Under: Screwed brass or iron body for 175 psig (1200 kPa) working pressure, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.
- C. Size 2-1/2 inch (65 mm) to 4 inch (100 mm): Flanged iron body for 175 psig (1200 kPa) working pressure, Y pattern with 3/64 inch (1.2 mm) stainless steel perforated screen.
- D. Size 5 inch (125 mm) and Larger: Flanged iron body for 175 psig (1200 kPa) working pressure, basket pattern with 1/8 inch (3.2 mm) stainless steel perforated screen.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Steam Traps:
 - 1. Provide minimum (3/4) inch (20) mm size on steam mains and branches.
 - 2. Install with union or flanged connections at both ends.
 - 3. Provide gate valve and strainer at inlet, and gate valve at discharge.
 - 4. Provide minimum 10 inch (250 mm) long, line size dirt pocket between apparatus and trap.
- C. Remove thermostatic elements from steam traps during temporary and trial usage, and until system has been operated and dirt pockets cleaned of sediment and scale.
- D. In high pressure and medium pressure mains, provide 3/4 inch (20 mm) nipple in bottom of main, extending 3/4 inch (20 mm) into and above bottom of pipe. Provide dirt pocket with 1/2 inch (13 mm) high pressure thermostatic trap.
- E. Provide pressure reducing stations with pressure reducing valve, valved bypass, strainer and pressure gage on upstream side, relief valve and pressure gage on downstream side of pressure reducing valve.
- F. Pressure reducing station shall be 1 or 2 stages as required, to produce flat reduced pressure curve over range of capacity, Locate pilot operator control minimum 6 feet (2 m) downstream of valve.
- G. Rate relief valves for pressure upstream of pressure reducing station, for full operating capacity. Set relief at maximum 20 percent above reduced pressure.

- H. Terminate relief valves to outdoors 2 feet (600 mm) minimum above roof. Provide drip pan elbow with drain connection to nearest floor drain.
- I. When several relief valve vents are connected to a common header, header cross section area shall equal sum of individual vent outlet areas.
- J. Install flowmeters in accordance with manufacturer's instructions. Provide straight lengths of piping upstream and downstream as required. Provide interconnecting power and control wiring and conduit in accordance with the provisions of Division 26 - Electrical. Coordinate with building automation system and automatic temperature controls. Provide programming and setup.

END OF SECTION 232218

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SECTION 232300 – REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping.
- B. Refrigerant.
- C. Moisture and Liquid Indicators.
- D. Valves.
- E. Strainers.
- F. Check Valves.
- G. Pressure Relief Valves.
- H. Filter-Driers.
- I. Solenoid Valves.
- J. Expansion Valves.
- K. Receivers.
- L. Flexible Connections.

1.2 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.
- B. Provide pipe hangers and supports in accordance with MSS SP69 unless indicated otherwise.
- C. Liquid Indicators:
 - 1. Use line size liquid indicators in main liquid line leaving condenser.
 - 2. If receiver is provided, install in liquid line leaving receiver.
 - 3. Use line size on leaving side of liquid solenoid valves.
- D. Valves:
 - 1. Use service valves on suction and discharge of compressors.
 - 2. Use gauge taps at compressor inlet and outlet.
 - 3. Use gauge taps at hot gas bypass regulators and at filters and filter driers, inlet and outlet.
 - 4. Use check valves on compressor discharge.
 - 5. Use check valves on condenser liquid lines on multiple condenser systems.

- E. Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.
 - F. Strainers:
 - 1. Use line size strainer upstream of each automatic valve.
 - 2. Where multiple expansion valves with integral strainers are used, use single main liquid line strainer.
 - 3. On steel piping systems, use strainer in suction line.
 - 4. Use shut-off valve on each side of strainer.
 - G. Pressure Relief Valves: Use on ASME receivers and on compressors converted to higher pressure refrigerant. Pipe field-installed valves and valves furnished with equipment to outdoors as required by ASHRAE Standard 15 and where directed.
 - H. Permanent Filter-Driers:
 - 1. Use in low temperature systems.
 - 2. Use in systems utilizing hermetic compressors.
 - 3. Use filter-driers for each solenoid valve.
 - I. Replaceable Cartridge Filter-Driers:
 - 1. Use vertically in liquid line adjacent to receivers.
 - 2. Use with filter elements in suction line. Provide temporary wax removal filter-drier core in low temperature systems and systems where motor failure has occurred.
 - 3. Use filter-driers for each solenoid valve.
 - J. Solenoid Valves:
 - 1. Use in liquid line of systems operating with single pump-out or pump-down compressor control.
 - 2. Use in liquid line of single or multiple evaporator systems.
 - 3. Use in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.
 - K. Receivers:
 - 1. Use on systems 5 tons (18 kW) and larger, sized to accommodate pump down charge.
 - 2. Use on systems with long piping runs.
 - L. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.
- 1.3 SUBMITTALS
- A. Submit under provisions of Division 01 Section "Submittal Procedures."
 - B. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.
 - C. Product Data: Provide general assembly of specialties, including manufacturer's catalog information. Provide manufacturer's catalog data including load capacity.

- D. Pipe Sizing Recommendations of Equipment Manufacturers:
 - 1. Verify indicated pipe sizes with the manufacturers of the associated equipment. If manufacturer's recommendations differ from the sizes indicated on the Drawings, submit recommendations to the Architect. The Architect will make the final determination of pipe sizes. Provide sizes per final determination at no additional cost to the Owner. In sizing piping, include modifications as required to affected items including but not limited to piping, valves, filters, other pipeline accessories, insulation, supports, sleeves, conduits, building openings, and building enclosures.
 - 2. Submission of manufacturer's recommendations, and equipment performance related to pipe sizing, is the Contractor's responsibility.
 - 3. Verify sizing prior to any preparation for piping installation.
 - E. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
 - F. Test Reports: Indicate results of leak test, acid test.
 - G. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.
 - H. Submit welders' certifications of compliance with AWS D1.1., and their assigned identification letters, numbers or symbols.
- 1.4 PROJECT RECORD DOCUMENTS
- A. Submit under provisions of Division 01 Section "Closeout Procedures."
 - B. Record exact locations of equipment and refrigeration accessories on record drawings.
- 1.5 OPERATION AND MAINTENANCE DATA
- A. Submit under provisions of Division 01 Section "Operation and Maintenance Data."
 - B. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.
- 1.6 QUALIFICATIONS
- A. Installer: Company specializing in performing the work of this Section with minimum 3 years' experience.
 - B. Design piping system under direct supervision of a Professional Engineer experienced in design of this work and licensed at the place where the Project is located.
- 1.7 REGULATORY REQUIREMENTS
- A. Conform to ASME B31.9 for installation of piping system.
 - B. Welding Materials and Procedures: Conform to ASME SEC 9 and applicable state labor regulations.
 - C. Welders Certification: In accordance with AWS D1.1. and state and local requirements.

- D. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.
- E. Refrigerant Safety: Conform with ASHRAE 15, state and local codes and manufacturer's requirements for safe handling to avoid exposure to workers or to occupants.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01 Section "Product Requirements."
- B. Deliver and store piping and specialties in shipping containers with labeling in place.
- C. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.
- D. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

1.9 MAINTENANCE MATERIALS

- A. Provide maintenance materials under provisions of Division 01 Section "Closeout Procedures."
- B. Provide two refrigeration oil test kits, each containing everything required to conduct one test.
- C. Provide two filter-dryer cartridges of each type.

PART 2 - PRODUCTS

2.1 PIPING

- A. Copper Tubing: ASTM B280, Type ACR hard drawn, degreased, nitrogen charged and sealed. Annealed (soft) tubing may be used only for underfloor or below grade runs or for short (6 feet or less) above-grade connections to valves and equipment.
 - 1. Fittings: ASME B16.22 wrought copper.
 - a. Fittings shall be packaged and labeled for ACR use.
 - b. Elbows: Use long-radius elbows wherever possible. Do not use 45-degree elbows, because they are more likely to break at their inner surface in refrigeration service.
 - 2. Joints:
 - a. Braze, 15% silver for copper, brass, and bronze.
 - b. Braze, 35% silver, for brazing to ferrous metals (steel).
 - c. Solder (for use only at equipment and valve connections where required by the equipment manufacturer).
 - d. Other: If a valve or equipment manufacturer recommends a joint material other than those specified, submit it for approval.
 - e. Flux: Use as recommended by alloy manufacturer. Should not be needed for copper-to-copper brazed joints.

- B. Copper Tubing to 7/8 inch (22 mm) OD: ASTM B88, Type K, annealed.
 - 1. Fittings: ASME B16.26 cast copper.
 - 2. Joints: Flared.

2.2 PIPE SUPPORTS AND ANCHORS

- A. Approved Manufacturers (first manufacturer is basis of design):
 - 1. Strut Hangers:
 - a. Unistrut (division of Tyco).
 - b. Anvil International.
 - c. Cooper B-Line.
 - d. Hydra-Zorb Company.
 - e. Thomas & Betts - Superstrut line.
 - f. Tolco (division of Nibco).
 - 2. Adjustable Swivel Band Hangers:
 - a. Carpenter & Paterson.
 - b. Anvil International.
 - c. Cooper B-Line.
 - d. Tolco (division of Nibco).
 - 3. Clevis Hangers:
 - a. Carpenter & Paterson.
 - b. Anvil International.
 - c. Cooper B-Line.
 - d. Tolco (division of Nibco).
 - 4. J-Hangers:
 - a. Carpenter & Paterson.
 - b. Cooper B-Line.
 - c. Thomas & Betts - Superstrut line.
 - d. Tolco (division of Nibco).
 - e. Unistrut (division of Tyco).
 - 5. Roof Support Blocks/Non-Penetrating Roof-Mounted Pipe Support System:
 - a. Cooper B-Line - Dura-Blok line.
 - b. Miro Industries.
 - c. Unistrut (division of Tyco) - Unipier line.
 - 6. Cushion Clamps:
 - a. Hydra-Zorb Company.
 - b. Cooper B-Line.
 - c. Thomas & Betts - Superstrut line.
 - d. Tolco (division of Nibco).
 - e. Unistrut (division of Tyco).
 - 7. Insulated Pipe Couplings:
 - a. Klo-Shure Corporation.
 - b. Cooper B-Line - Armafix line.
 - 8. No substitutions.
- B. Conform to MSS SP69.
- C. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Carbon steel, adjustable swivel, split ring.
- D. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.

- E. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- F. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
- G. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
- H. Vertical Support: Steel riser clamp.
- I. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- J. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- K. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
- L. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
- M. Struts: Provide equal to Unistrut where required. Cadmium or electro-zinc plating is suitable for dry indoor locations only.
- N. Finish for Outdoor or Wet Locations: Hot dip galvanized, stainless steel or epoxy painted. Provide copper plating where metal is in contact with copper pipe.
- O. Support Size: Size to fit outside the pipe insulation.
- P. Cushion Clamps: Hydrazorb, for use with bare pipes mounted on struts.

2.3 BRAZING MATERIALS - 15% Silver

- A. Manufacturers:
 - 1. Harris (Product: Stay-Silv 15).
 - 2. Lucas-Milhaupt (Product: Sil-Fos 15).
 - 3. Wolverine (Product: Silvaloy 15).
 - 4. No substitutions.
- B. Nominal Composition: 5.0% phosphorus, 15.0% silver, 0.15% other elements (total), remainder copper. Cadmium-free.
- C. Physical Properties:
 - 1. Color: Yellow/Gray
 - 2. Solidus: 1190°F
 - 3. Liquidus: 1480°F
 - 4. Brazing Range: 1300 - 1500°F
 - 5. Electrical Conductivity: 9.9% IACS
 - 6. Electrical Resistivity: 17.40 Microhm-cm
- D. Specification Compliance:
 - 1. ANSI/AWS A5.8, class BCuP-5
 - 2. ASME SFA5.8, class BCuP-5

- 3. Optional:
 - a. QQB 650C, class BCuP-5
 - b. QQB 654A, class BCuP-5
 - c. QQB 654, class BCuP-5

- E. Flux:
 - 1. Harris (Stay-Silv For copper-to-brass joints. No flux required for copper-to-copper joints).

2.4 BRAZING MATERIALS - 35% Silver

- A. Manufacturers:
 - 1. Harris (Product: Safety-Silv 35).
 - 2. Lucas-Milhaupt (Product: Braze 351).
 - 3. Wolverine (Product: Silvaloy A-35).
 - 4. No substitutions.
- B. Nominal Composition: 35.0% silver, 33% Zinc, 0.15% other elements (total), remainder copper. Cadmium-free.
- C. Physical Properties:
 - 1. Color: Yellow/Gray
 - 2. Solidus: 1250°F (677°C)
 - 3. Liquidus: 1410°F (732°C)
 - 4. Electrical Conductivity: 19.8% IACS
 - 5. Electrical Resistivity: 8.2 Microhm-cm
- D. Specification Compliance:
 - 1. ANSI/AWS A5.8, class BAg-5
 - 2. ASME SFA5.8, class BCuP-5
- E. Flux:
 - 1. Harris (Stay-Silv white flux, or where heating cycles are extended, Stay-Silv black flux).

2.5 SOLDER MATERIALS:

- A. Manufacturers:
 - 1. Harris (Product: Stay-Brite).
 - 2. Lucas-Milhaupt (Product: Clean 'n Brite).
 - 3. Wolverine (Product: Silvabrite).
 - 4. No substitutions.
- B. Nominal Composition: Alloy of silver and tin (3-6% Ag, remainder Sn). Antimony-free.
- C. Physical Properties:
 - 1. Color: Bright Silver
 - 2. Solidus: 430°F
 - 3. Liquidus: 430°F
 - 4. Electrical Conductivity: 16.4% IACS
 - 5. Shear Strength: 10,600 psi
 - 6. Tensile Strength: 14,000 psi
 - 7. Elongation: 48%

- D. Specification Compliance:
 - 1. NSF 51
 - 2. ASTM B32-89, Alloy Grade Sn96
 - 3. Federal Spec. QQ-S-571E, Class Sn 96 with exception to QPL paragraph 3.1
 - 4. J-STD-006, Sn96Ag04A
- E. Flux:
 - 1. Harris (Product: Stay Clean Paste Flux, Stay Clean Liquid Flux (used with 4" or larger copper tubing also stainless steels), or Bridgit Water Soluble Paste Flux).
 - 2. Canfield (Product: Aqua-Brite or AB Cream Flux). Glycerin-based, water soluble.

2.6 REFRIGERANTS AND LUBRICANTS

- A. Refrigerant: ASHRAE 34;
 - 1. R-410a: Blend of R-32/125.
- B. Oils and Other Lubricants: Provide as required by the refrigerant manufacturer and the equipment manufacturer(s).

2.7 MOISTURE AND LIQUID INDICATORS

- A. Manufacturers:
 - 1. Sporlan Valve Co, Model "See-All".
 - 2. Emerson Climate Technologies.
 - 3. Henry Technologies.
 - 4. Mueller.
- B. Indicators: Double port type, UL listed, with steel body, flared or copper plated solder ends, leak proof fused sight glass, replaceable color coded paper moisture indicator and plastic cap; for maximum working pressure of 500 psig for connection sizes 1-1/8 inch O.D. and smaller, 430 psig for sizes 1-3/8 inch O.D. and larger, and maximum temperature of 200°F. Synthetic gaskets are not allowed.

2.8 VALVES

- A. Diaphragm Packless Valves:
 - 1. Manufacturers:
 - a. Henry Technologies.
 - b. Mueller.
 - c. Superior.
 - 2. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psig and maximum temperature of 275°F.
- B. Packed Angle Valves:
 - 1. Manufacturers:
 - a. Henry Technologies.
 - b. Mueller.
 - c. Superior.

2. Forged brass (or brass and copper), forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psig and maximum temperature of 275°F.
- C. Ball Valves:
1. Manufacturers:
 - a. Henry Technologies.
 - b. Mueller.
 - c. Superior.
 2. Two piece forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psig and maximum temperature of 325°F.
- D. Service Valves:
1. Manufacturers:
 - a. Henry Technologies.
 - b. Mueller.
 - c. Superior.
 2. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psig.

2.9 CHECK VALVES

- A. Globe Type:
1. Manufacturers:
 - a. Henry Technologies.
 - b. Mueller.
 - c. Superior.
 2. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum working pressure of 500 psig and maximum temperature of 300°F.
- B. Straight Through Type:
1. Manufacturers:
 - a. Henry Technologies.
 - b. Mueller.
 - c. Superior.
- C. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psig and maximum temperature of 250°F.

2.10 EXPANSION VALVES

- A. Manufacturers:
1. Sporlan.
 2. Henry Technologies.
 3. Parker Hannifin.

- B. Angle or Straight Through Type: ARI 750; balanced port or two-port design suitable for refrigerant, brass body, flare or solder connections, internal or external equalizer, resealable bleed hole, adjustable superheat setting, replaceable inlet strainer, with replaceable thermostatic power element with capillary tube and remote sensing bulb. Joints to the body at the removable power element and at the strainer shall be knife-edge type not requiring a synthetic seal.
- C. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10° F. superheat. Select to avoid being undersized at full load and excessively oversized at part load. Select thermostatic charge for the particular application.

2.11 ELECTRONIC EXPANSION VALVES

- A. Manufacturers:
 - 1. Sporlan.
 - 2. Henry Technologies.
 - 3. Parker Hannifin.
- B. Valve:
 - 1. Brass body with flared or solder connection, needle valve with floating needle and machined seat, stepper motor drive.
 - 2. Capacity: To meet the load of the equipment served.
 - 3. Electrical Characteristics: Compatible with the control system.
- C. Evaporation Control System:
 - 1. Electronic microprocessor based unit in enclosed case, proportional integral control with adaptive superheat, maximum operating pressure function, preselection allowance for electrical defrost and hot gas bypass.
 - 2. Electrical Characteristics: Compatible with the control system.
- D. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

2.12 PRESSURE REGULATORS

- A. Manufacturers:
 - 1. Sporlan.
 - 2. Parker Hannifin.
- B. Brass body, stainless steel diaphragm, pilot operated with internal pressure pilot, adjustable over 0 to 100 psig range, for maximum working pressure of 450 psig.

2.13 PRESSURE RELIEF VALVES

- A. Manufacturers:
 - 1. Henry Technologies.
 - 2. Mueller.
 - 3. Superior.

- B. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB; for standard setting; selected to ASHRAE 15.

2.14 SOLENOID VALVES

- A. Manufacturers:
 - 1. Sporlan.
 - 2. Henry Technologies.
 - 3. Parker Hannifin.
- B. Valve: ARI 760, pilot operated, brass or steel body and internal parts, teflon seat, stainless steel stem and plunger assembly, with flared, solder, or threaded ends; for maximum working pressure of 500 psig. Stem shall have a knife-edge joint to the body and shall permit manual operation in case of coil failure.
- C. Coil Assembly: UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box with pilot light.
- D. Electrical Characteristics: 10 to 15 watts, voltage compatible with control system, single phase, 60 Hz.

2.15 FILTER-DRIERS

- A. Replaceable Cartridge Angle Type:
 - 1. Manufacturers:
 - a. Sporlan, Model CW Catch-All.
 - b. Emerson Climate Technologies.
 - 2. Shell: ARI 710, UL listed, steel with epoxy paint finish, copper sweat fittings, removable cap with zinc-plated fasteners, for maximum working pressure of 500 psig, size as recommended by manufacturer.
 - 3. Suction Filter Cartridge: Pleated media with integral end rings, stainless steel support, ARI 730 rating for capacity of the equipment served.
 - 4. Filter/Dryer Cartridge: Pleated media with solid core molecular sieve with activated alumina, ARI 730 rating for capacity of the equipment served.
 - 5. Wax Removal Cartridge: Molded bonded core of activated charcoal with integral gaskets, with filter surface area, desiccant volume and ARI 710 moisture rating as recommended by the manufacturer based on line size and refrigeration system horsepower (kW).
- B. Permanent Straight Through Type:
 - 1. Manufacturers:
 - a. Sporlan, Model CW Catch-All.
 - b. Emerson Climate Technologies.
 - 2. ARI 710, UL listed, steel shell with copper plated steel sweat or flare fittings, molded molecular sieve/activated alumina desiccant filter core, for maximum working pressure of 500 psig.
 - 3. Rating: ARI 730 flow capacity of the equipment served.

2.16 FLEXIBLE CONNECTORS

- A. Manufacturers:
 - 1. Metraflex.
 - 2. Mason Industries.
 - 3. Keflex.
- B. Corrugated bronze hose with single layer of exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure 500 psig.

2.17 RECEIVERS

- A. Manufacturers:
 - 1. Henry Technologies.
 - 2. Refrigeration Research Inc.
 - 3. Sporlan.
 - 4. Standard Refrigeration Co.
- B. Internal Diameter 6 inch and Smaller: ARI 495, UL listed, steel, brazed; 400 psig maximum pressure rating, with tappings for inlet, outlet, liquid level gauge, sight glasses and pressure relief valve. Provide at least two (2) bullseye liquid level sight glasses. Size receiver to hold at least 120% of fully charged system.
- C. Internal Diameter Over 6 inch: ARI 495, welded steel, tested and stamped in accordance with ASME SEC 8D; 400 psig with tappings for liquid inlet and outlet valves, pressure relief valve, sight glasses and magnetic liquid level indicator. Provide at least two (2) bullseye liquid level sight glasses. Size receiver to hold at least 120% of fully charged system.

2.18 STRAINERS

- A. Straight Line or Angle Line Type:
 - 1. Manufacturers:
 - a. Henry Technologies.
 - b. Sporlan.
 - c. Superior.
 - 2. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psig.
- B. Straight Line, Non-Cleanable Type:
 - 1. Manufacturers:
 - a. Henry Technologies.
 - b. Mueller.
 - 2. Steel shell, copper plated fittings, stainless steel wire screen, for maximum working pressure of 430 psig.
- C. Screens: 80 mesh (0.007 in. square openings) in most uses, 60 mesh (0.010 in.) square openings) in line sizes above 1-1/8 inch, and 40 mesh (0.015 in. square openings) for use in suction lines.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Install refrigeration specialties in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, parallel or perpendicular to building structure, and maintain gradient.
- C. Install annealed piping free of kinks, and with bends only as necessary.
- D. Install PVC conduit joints per ASTM D 2855, and handle cement per ASTM F402. Prime joints, apply a full coat of cement, insert piping while cement is wet, and rotate at least 1/4 turn to spread cement. Conduit shall be watertight.
- E. Install piping to conserve building space and not interfere with use of space.
- F. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
- G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- H. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of, or recessed into and grouted flush with, slab.
- I. Pipe Hangers and Supports:
 - 1. Install in accordance with MSS SP89.
 - 2. Support horizontal piping as scheduled.
 - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
 - 5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 - 6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

7. Provide copper plated hangers and supports for copper piping when hanger must contact the piping.
 8. Provide cushion clamps when bare pipes (pipes on which insulation is not specified) are used with strut hangers or vertical risers.
- J. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required.
- K. Pipe Sleeves and Escutcheons:
1. Provide sleeves, sized to fit outside the pipe insulation with at least 1/4" clearance, at penetrations of building assemblies. Interrupt insulation where required by fire ratings.
 2. Extend floor sleeves to 2 in. above finished floor and seal watertight.
 3. For below-grade penetrations and where indicated, provide watertight link-type pipe seals.
 4. Secure sleeves in place, and caulk, grout or firestop into the building assembly.
 5. Provide split chrome or painted escutcheons where exposed to occupancy.
- L. Provide clearance for installation of insulation and access to valves and fittings.
- M. Provide access to concealed valves and fittings.
- N. Flood piping system with nitrogen when brazing.
- O. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.
- P. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting.
- Q. Insulate piping and equipment; refer to Division 23 Sections "HVAC Piping Insulation."
- R. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.
- S. Provide liquid line replaceable cartridge (unless sealed type is indicated) filter-driers, with isolation valves and valved bypass. On low temperature systems, or after a hermetic motor burnout, provide wax removal cores. Provide upstream and downstream pressure-testing access valves.
- T. Provide suction line replaceable cartridge filters, with isolation valves and valved bypass. Provide upstream and downstream pressure testing access valves. On low temperature systems, or after a hermetic motor burnout, provide temporary wax removal cores. After cleanup of the system, replace cores with filter elements for lower pressure drop.
- U. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
- V. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
- W. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
- X. Fully charge completed system with refrigerant after testing.
- Y. Provide electrical connection to solenoid valves. Refer to Division 26.

3.3 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Division 01 Section "Quality Requirements."
- B. Test refrigeration system in accordance with ASME B31.5.
- C. Pressure test system with dry nitrogen to 200 psig. Perform final tests at 27 inches vacuum and 200 psig pressure using electronic leak detector. Test to no leakage.
- D. Evacuate the system as required by Codes and by equipment manufacturer, including a vacuum test at 0.02 inches of mercury. The system shall be valved off and tested for 2 hours with a pressure rise of no more than 0.002 inches of mercury.

3.4 SYSTEM STARTUP

- A. Lubricate motors and other moving parts as necessary before operating them.
- B. Charge the system with liquid refrigerant into the low pressure side of the system, where the liquid will evaporate. Expel air from the system. Operate the compressor, condenser, water cooling pumps and evaporator fans during charging. Monitor compressor discharge pressure. Monitor oil levels for a period of 24 hours.
- C. Coordinate control setpoints and wiring prior to startup.
- D. Change suction filter elements if the pressure drop exceeds 1 Psi after the initial 24 hours of operation. Change suction wax removal cores to filter elements after system cleanup.
- E. Adjust expansion valve superheat using a thermistor or thermocouple temperature sensor at the bulb location and a pressure gauge at the external equalizer line (or the compressor). Adjust under full system load, and again when the system stabilizes.
- F. Check the system again after seven full days of operation.
- G. Periodically clean strainers until no more accumulation occurs.

3.5 SCHEDULES

- A. State and Local Codes: If code requirements are more stringent than those indicated herein, provide as required by code.

B. Pipe Hanger Spacing:

PIPE SIZE		HANGER ROD MAX. HANGER SPACING		ROD DIAMETER	
Inches	mm	Feet		Inches	
3/8 to 1-1/4	9 to 32	6.5		3/8	
1-1/2 to 2	38 to 50	10		3/8	
2-1/2 to 3	62 to 75	10		1/2	

END OF SECTION 232300

SECTION 232500 – HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cleaning of piping systems.
- B. Chemical feeder equipment.
- C. Chemical treatment.

1.2 RELATED SECTIONS

- A. Division 23 Section “Instrumentation and Controls For Mechanical Systems.”
- B. Division 26 “Electrical”: Electrical characteristics and wiring connections.

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures.”
- B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
- C. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.
- D. Submit certificate of compliance from authority having jurisdiction indicating approval of chemicals and their proposed disposal.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01 Section “Operation and Maintenance Data.”
- B. Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years’ experience. Company shall have local representatives with water analysis laboratories and full time service personnel.
- B. Installer: Company specializing in performing the work of this Section with minimum 3 years’ experience and approved by manufacturer.

1.7 REGULATORY REQUIREMENTS

- A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems, and for discharge to public sewage systems.
- B. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

1.8 MAINTENANCE SERVICE

- A. Furnish service and maintenance of treatment systems for 1-year from Date of Substantial Completion.
- B. Provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit 2 copies of field service report after each visit.
- C. Provide laboratory and technical assistance services during this maintenance period.
- D. Include 2-hour training course for Owner's operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems. Schedule the course at Owner's convenience after start-up of systems.
- E. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

1.9 MAINTENANCE MATERIALS

- A. Provide maintenance materials under provisions of Division 01 Section "Product Requirements."
- B. Provide sufficient chemicals for treatment and testing during warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Chemical Treatment Systems Products, and Services:
 - 1. Barclay Water Management, Inc., Watertown, MA office.
 - 2. Nalco Company, Windham, ME office.
- B. Chemical Treatment Products:
 - 1. Nu-Calgon.
 - 2. Culligan.
 - 3. H-O-H Water Technology, Inc.
 - 4. Wesco Chemicals, Inc.

2.2 MATERIALS

- A. System Cleaner:
 - 1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodium tripoly phosphate and sodium molybdate.
 - 2. Biocide; chlorine release agents such as sodium hypochlorite or calcium hypochlorite, or microbiocides such as quarternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones.
- B. Closed System Treatment (Water):
 - 1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
 - 2. Corrosion inhibitors; liquid boron-nitrite, sodium nitrite and borax, sodium totyltriazone, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
 - 3. Conductivity enhancers; phosphates or phosphonates.

2.3 BY-PASS (POT) FEEDER

- A. Manufacturers:
 - 1. Neptune Chemical Pump Co.: Model DBF-5HP.
 - 2. General Treatment Products, Inc.: Model DB5-QC-AR.
 - 3. Griswold Water Sytems: Model DB-5-GE-CS-Z-230.
 - 4. Wheatley - a division of Global Flow Products: Model VFT-005-0.
 - 5. No substitutions.
- B. 5.0 gal (18.9 l), with quick opening cap (coarse threaded or Victaulic grooved coupling type), domed (convex) top and bottom, for working pressure of 200 psig (1370 kPa) at 200 degrees F (93 degrees C), fittings as required for piping configuration indicated on the Drawings, minimum of 3/4 inch (19 mm) FPT inlet, outlet, and bottom drain.
- C. Provide fitting for air vent ball valve, either on the feeder or on piping, to allow release of pressure before opening the cap.
- D. Plug any unused openings.
- E. Open fill funnel is not desired. If a fill funnel is provided, provide a lockable ball valve, and padlock with 3 keys, to prevent tampering. If more than one lock is provided, they shall be keyed alike. Furnish keys to the Owner.
- F. Install above the floor with legs or pedestal. For feeders which don't have integral legs or pedestal, provide additional support or concrete housekeeping pad.

2.4 TEST EQUIPMENT

- A. Provide white enamel test cabinet with local and fluorescent light, capable of accommodating 4 – 10 ml zeroing titrating burettes and associated reagents.
- B. Provide the Following Test Kits (verify suitability for the installed hot water piping systems):
 - 1. Alkalinity titration test kit.
 - 2. Chloride titration test kit.
 - 3. Sulphite titration test kit.
 - 4. Total hardness titration test kit.

5. Low phosphate test kit.
6. Conductivity bridge, range 0 - 10,000 microhms.
7. Creosol red pH slide complete with reagent.
8. Portable electronic conductivity meter.
9. High nitrite test kit.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning.
- C. Verify that electric power is available and of the correct characteristics.

3.2 CLEANING SEQUENCE

- A. Concentration:
 1. As recommended by manufacturer.
 2. 1 pound per 100 gallons (1 kg per 1000 L) of water contained in the system.
 3. 1 pound per 100 gallons (1 kg per 1000 L) of water for hot systems and 1 pound per 50 gallons (1 kg per 500 L) of water for cold systems.
 4. Fill steam boilers only with cleaner and water.
- B. Hot Water Heating Systems:
 1. Apply heat while circulating, slowly raising temperature to 160 degrees F (71 degrees C) and maintain for 12 hours minimum.
 2. Remove heat and circulate to 100 degrees F (37.8 degrees C) or less; drain systems as quickly as possible and refill with clean water.
 3. Circulate for 6 hours at design temperatures, then drain.
 4. Refill with clean water and repeat until system cleaner is removed.
- C. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect/Engineer.
- D. Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill.
- E. Remove, clean, and replace strainer screens.
- F. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.4 CLOSED SYSTEM TREATMENT

- A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.
- B. Introduce closed system treatment through bypass feeder when required or indicated by test.
- C. Provide 30% solution of inhibited propylene glycol for glycol heating system.

END OF SECTION 232500

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SECTION 233113 – METAL DUCTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Metal Ductwork.
 - 1. Low pressure
- B. Air Duct Leakage Tests.

1.2 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Division 23: Sensors and airflow measuring stations furnished under Division 23 Section “Instrumentation and Control for Mechanical Systems”; gauges and meters.
- B. Division 26 – Electrical: Smoke detectors.

1.3 RELATED SECTIONS

- A. Division 23 Section “Testing, Adjusting and Balancing for HVAC.”
- B. Division 09 Section for painting: Weld priming, weather resistant, paint or coating.
- C. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment”: Sleeves.
- D. Division 23 Section “Duct Insulation”: External insulation and duct liner.
- E. Division 23 Section “Air Duct Accessories”
- F. Division 23 Section “Air Outlets and Inlets.”

1.4 REFERENCES

- A. ASTM A 36 - Structural Steel.
- B. ASTM A 90 - Standard Test Method for Weight of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
- C. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- D. ASTM A 480 - General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
- E. ASTM A 568 - Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled.
- F. ASTM A 653 - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- G. ASTM A 1008 - Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy,

High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.

- H. ASTM A 1011 - Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- I. ASTM B 209 - Aluminum and Aluminum-Alloy Sheet and Plate.
- J. ASTM C 14 - Concrete Sewer, Storm Drain, and Culvert Pipe.
- K. ASTM C 443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
- L. AWS D9.1 - Welding of Sheet Metal.
- M. NBS PS 15 - Voluntary Product Standard for Custom Contact-Molded Reinforced-Polyester Chemical Resistant Process Equipment.
- N. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- O. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.
- P. NFPA 91 - Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying.
- Q. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment.
- R. SMACNA - HVAC Air Duct Leakage Test Manual.
- S. SMACNA - HVAC Duct Construction Standards - Metal and Flexible (SMACNA HVACDCS).
- T. SMACNA - Fibrous Glass Duct Construction Standards.
- U. UL 181 - Factory-Made Air Ducts and Connectors.
- V. UL 2221 - Tests of Fire Resistive Grease Duct Enclosure Assemblies.

1.5 PERFORMANCE REQUIREMENTS

- A. No variation of duct configuration or sizes is permitted except by written permission from the Architect. Size proposed substitutions of round ducts in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.6 SUBMITTALS

- A. Submit under provisions of Division 01 Section "Submittal Procedures".
- B. Shop Drawings: Indicate duct fittings, particulars such as gauges, sizes, welds, and configuration. Submit prior to start of work.
- C. Product Data: Provide data for duct materials, duct liner and duct connectors.

- D. Test Reports: Submit testing apparatus, procedures, and preliminary forms prior to performing tests. On final reports, indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

1.7 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01 Section "Closeout Procedures."
- B. Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Indicate additional fittings used.

1.8 QUALITY ASSURANCE

- A. Perform Work in accordance with SMACNA HVACDCS.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum 3 years' experience.
- B. Installer: Company specializing in performing the work of this Section with minimum 3 years' experience.

1.10 REGULATORY REQUIREMENTS

- A. Construct ductwork to NFPA 90A, NFPA 90B and NFPA 96 standards.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures during and after installation of duct sealants.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Flexible Ducts:
 - 1. Flexible Technologies Group - Thermaflex product line.
 - 2. Buckley Associates - Flexmaster Triple-Lock Buck Duct product line.
 - 3. No substitutions.
- B. Plastic Drawbands:
 - 1. Panduit.
 - 2. Thomas and Betts.
 - 3. Tyton.
- C. Tape for Flexible Ducts:
 - 1. Ideal Tape Co., division of American Biltrite Inc.
 - 2. 3M Company.

3. Nashua Tape Products, division of Berry Plastics Corp.
4. Venture Tape Corporation.
5. No substitutions.

D. Manufactured Ductwork - Round and Flat Oval:

1. McGill AirFlow LLC, a subsidiary of United McGill Corporation.
2. Aero Heating & Ventilating, Inc.; Portland, ME.
3. Air Purchases, Inc.; Manchester, NH – spiral duct lengths.
4. Atlantic Air Products LLC; Bow, NH.
5. Central City Sheet Metal; Brewer, Caribou, and Gorham, ME.
6. Hahnel Brothers; Bangor and Lewiston, ME.
7. Hranec Corporation; Uniontown, PA.
8. Lindab, Inc. – duct fittings only.
9. Macy Industries, Inc.; Hookset, NH.
10. Monroe Metal Mfg. Inc.; Monroe, NC.
11. Northeastern Sheet Metal Inc.; Goffstown, NH.
12. Semco Inc., division of the Flakt Woods Group.
13. S.G. Torrice Co.; Wilmington, MA – spiral duct lengths.
14. Sheet Metal Connectors Inc.; Minneapolis, MN.
15. Spiral Manufacturing Co. Inc.; Minneapolis, MN.
16. Total Air Supply; Nashua, NH – spiral duct lengths.
17. No substitutions.

E. Manufactured Ductwork - Transverse Duct Connection System:

1. Ductmate.
2. HFC Enterprises; Baldwin Park, CA – Dura Flange product line, for round and flat oval ducts only.

F. Sealants:

1. Hardcast, a division of Carlisle Corporation.
2. 3M Company.
3. Ductmate.
4. Foster.
5. McGill AirSeal LLC, a subsidiary of United McGill Corporation.
6. Mon-Eco Industries, Inc - Eco product line.
7. Polymer Adhesive Sealant Systems.

2.2 MATERIALS

A. Galvanized Steel Ducts:

1. Steel sheet metal components of galvanized ductwork in this Specification Section shall be galvanized steel sheet, lock-forming quality, having G60 or heavier zinc coating (G90 minimum for outdoor or moist applications) conforming to ASTM A653 rating system and tested in accordance with ASTM A90.
2. Provide paint-grip exterior surfaces for exposed ducts, where available.
3. Sheet metal gauge shall be not less than 26 gauge (0.56 mm).

2.3 FLEXIBLE DUCTS

A. Insulated Flexible Ducts:

1. Semi-Rigid Flexible Aluminum Ductwork:
 - a. Flexmaster Triple-Lock Buck Duct - Insulated.
 - b. Triple lock mechanical joint aluminum flex duct, constructed entirely without the use of adhesive.
 - c. Fiberglass insulation and fire-retardant polyethylene vapor retarder film.
 - d. Pressure Rating: Positive pressure 12 in. WG (2988 Pa) for all sizes. Negative pressure 12 in. WG (2988 Pa) for sizes thru 16 in. (406 mm) diameter, 8 in. WG (1993 Pa) for sizes 18 and 20 in. (457 and 508 mm) diameter.
 - e. Maximum Velocity: 5500 fpm (27.9 m/sec).
 - f. Inside bend radius: Minimum one diameter.
 - g. Temperature Range: -40 to 250 degrees F (-40 to 121 degrees C).
 - h. UL 181, Class 0 air duct.
 - i. Meets NFPA 90A and 90B standards.
2. Fabric-Core Flexible Ductwork:
 - a. Thermaflex Model M-KC.
 - b. Greenguard certified.
 - c. UL 181, Class 1, heavy fiberglass cloth fabric supported by helically wound spring steel wire; fiberglass insulation; reinforced metalized vapor barrier film.
 - d. Pressure Rating: 10 inches WG (2.5 kPa) positive and 2.0 inches WG (500 Pa) negative.
 - e. Maximum Velocity: 6000 fpm (30.4 m/sec).
 - f. Temperature Range: -20 to 250 degrees F (-28 to 121 degrees C).

B. Non-Insulated Flexible Ducts:

1. Semi-Rigid Flexible Aluminum Ductwork:
 - a. Flexmaster Triple-Lock Buck Duct - Bare.
 - b. Triple lock mechanical joint aluminum flex duct, constructed entirely without the use of adhesive.
 - c. Pressure Rating: 12 inches WG (2988 Pa) positive for all sizes, 12 inches WG (2988 Pa) negative for sizes thru 16 in. diameter (406 mm), 8 inches WG (1992 Pa) negative for sizes 18 in. (457 mm) and 20 in. (508 mm) diameter.
 - d. Maximum Velocity: 5500 fpm (27.9 m/sec).
 - e. Inside bend radius: Minimum one diameter.
 - f. Temperature Range: -40 to 250 degrees F (-40 to 121 degrees C).
 - g. UL 181, Class 0 air duct.
 - h. Meets NFPA 90A and 90B standards.

- C. Return and Exhaust: Use either semi-rigid flexible aluminum type (insulated or bare), or fabric-core type (insulated). Non-insulated fabric-core type does not have adequate negative pressure rating.

2.4 ACCESSORIES

A. Drawbands for Flexible Ducts:

1. Stainless Steel: ½ inch (13 mm) wide with screw-driven worm gear.
2. Plastic: Panduit PLT5H or PLT8H; Thomas and Betts Dukt-Rap, VAL-26-50, or VAL-275X-25; or Tyton T150L or LX. Install with manufacturer's lever-action tightening tool.

- B. Tape for Flexible Ducts: Ideal-Seal 587A/B, UL 181B-FX listed, aluminum foil with pressure-sensitive acrylic adhesive, -20 to 250 degrees F (-28 to 121 degrees C) temperature range, 25.0 lb/in. width (109.4 N/25.4 mm width) tensile strength.
- C. Fasteners: Rivets, bolts, or sheet metal screws.
- D. Sealants: See Duct Sealant portion of this Specification.
- E. Hanger Rod: ASTM A36; galvanized steel; threaded both ends, threaded one end, or continuously threaded.

2.5 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA HVACDCS, as specified or as indicated on the drawings. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- B. SMACNA Duct Construction Manuals:
 - 1. The SMACNA recommendations shall be considered as mandatory requirements.
 - 2. Substitute the word "shall" for the word "should" in these manuals.
 - 3. Where the Contract Specifications differ from SMACNA recommendations, the more stringent requirements (as determined by the Architect) shall take precedence.
 - 4. Details on the Contract Drawings take precedence over SMACNA standards.
- C. Sheet metal shall be galvanized steel as specified in Part 2 paragraph "Materials" in this Section, unless otherwise indicated or specified.
- D. Construct Tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline.
 - 1. Where space is too restricted for full-radius elbows, provide mitered (square-throat) elbows with single wall turning vanes. Do not use air foil turning vanes.
 - 2. Mitered elbows in round or flat-oval ductwork shall be factory-manufactured.
 - 3. Radiused elbows with throat radius 1/2 times width of duct (centerline radius 1 width of duct) may be used instead of mitered elbows, but only where space is too restricted for full radius.
 - 4. Fittings not conforming to these requirements will be ordered removed and replaced with proper fittings.
- E. Increase duct sizes gradually, not exceeding 15 degrees divergence or convergence (per side) wherever possible; maximum 30 degrees divergence (per side) upstream of equipment and 45 degrees convergence (per side) downstream.
- F. Fabricate continuously welded round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints shall be minimum 4 inch (100 mm) cemented slip joint, brazed or electric welded. Prime coat welded joints.
- G. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.
- H. Longitudinal locks or seams known as "button-punch-snap-lock" and other "snap-lock" types will not be permitted in rectangular duct. Snap-lock longitudinal seams may be used on round

ducts up to 8 inches diameter, with screws provided to secure the seams at 24 inches (609 mm) on center maximum spacing.

2.6 MANUFACTURED DUCTWORK AND FITTINGS

- A. Manufactured ductwork and fittings listed below are acceptable alternatives to standard ductwork systems. For exposed round and flat oval ductwork, factory-manufactured ductwork and fittings are required.
- B. Manufacture in accordance with SMACNA HVACDCS, and as specified or as indicated on the drawings. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- C. Galvanized and stainless steel sheet metal used in fabrication shall be not less than 26 gauge (0.551 mm) thickness. Aluminum shall be not less than 0.025 in. (0.635 mm) nominal thickness. This requirement supersedes SMACNA requirements.
- D. Round and Flat Oval Duct and Fittings:
 - 1. Shall be suitable for at least 4 in. WG (996 Pa) positive pressure and 2 in. WG (498 Pa) negative pressure in accordance with SMACNA HVACDCS standards. This is a minimum; provide higher ratings where required.
 - 2. Fittings shall be fabricated of sheet metal at least one gauge heavier than straight duct of the same size.
 - 3. Fittings shall be factory-sealed so that no field sealing of joints between gores or segments is required. Acceptable methods of construction are fully welded, spot-welded with inner sealant, or standing-seam crimped joints.
- E. Radiused Elbows in Round and Flat Oval:
 - 1. In exposed ductwork shall be non-adjustable type, factory-sealed.
 - 2. In concealed ductwork may be adjustable type, with full long radius as detailed on the Drawings. Short-radius elbows are not allowed.
 - 3. Shall be constructed of the following minimum number of segments or gores: 90-degree: 4 gores; 60-degree: 3 gores; 45-degree: 3 gores; 30-degree: 2 gores; 22-1/2-degree: 2 gores.
 - 4. 1-piece stamped elbows are acceptable up to 12 inches (305 mm) diameter. Pleated elbows are acceptable up to 10 inches (254 mm) diameter.
- F. Mitered Elbows in Round and Flat Oval:
 - 1. Available in both 90-degree and 45-degree elbows.
 - 2. Shall have minimum number of welded single-wall vanes as follows (size is duct width in plane of bend):
 - a. 3 to 9 inch (76 to 229 mm): 2.
 - b. 10 to 14 inch (254 to 356 mm): 3.
 - c. 15 to 19 inch (381 to 483 mm): 4.
 - d. 20 to 60 inch (508 to 1524 mm): 5.
 - e. Larger Sizes: 12-inch (305 mm) maximum spacing.
- G. Inner tie-rod reinforcement is not allowed. Increase duct sheet metal gauge or external reinforcement as required.
- H. Flat Oval Ducts: Machine made from round spiral lockseam duct.

- I. Double Wall Insulated Round Ducts: Round spiral lockseam duct with galvanized steel outer wall, 1 inch (25 mm) thick fiberglass insulation, perforated galvanized steel inner wall; fittings with solid inner wall.
- J. Transverse Duct Connection System: SMACNA "F" rated or SMACNA "J" rated rigidity class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips. Product shall be Ductmate factory-manufactured connectors, or field-formed flanges using a specialized machine.

2.7 PRESSURE CLASSIFICATION

- A. Ratings as indicated on the Drawings or as specified. See Ductwork Pressure Class Schedule in Part 3 of this Section.
- B. If no ratings are indicated, ductwork shall be rated for the external static pressure of the system plus 25 percent.
 - 1. If 4 dampers (of any type) or fewer can isolate a duct system, that portion of the system shall be rated for the shut-off pressure of the system fans.

2.8 DUCT SEALING

- A. Seal ductwork as outlined in the SMACNA HVACDCS. Seal ductwork to a minimum of class A (transverse joints, longitudinal seams, and duct wall penetrations), regardless of pressure class.
- B. Seal ductwork systems as required to ensure that maximum duct leakage does not exceed that allowed by the latest edition of the SMACNA HVAC Air Duct Leakage Test Manual. Allow sealant to dry in accordance with manufacturer's requirements of time and environmental conditions before ductwork systems are pressurized.
- C. Duct sealing materials used shall be non-flammable and non-combustible in both liquid and solid states.
- D. Seal Pittsburgh hammered lockseams by flooding the joint with sealant prior to assembly.
- E. Seal exposed ducts by applying mastic-type or gasket-type sealer just before the joint or seam is made; remove excess sealant for a neat appearance.
- F. Fill (with matching duct material such as sheet metal) any gaps in duct which exceed the recommendations of the sealant manufacturer, and in no case shall liquid or mastic sealant be used to fill gaps or openings which exceed 1/8 inch (3.2 mm) in any direction. Verify that system air pressure acting on a wide gap will not exert enough force to damage or loosen the sealant.
- G. Materials for Sealing:
 - 1. Hardcast: Flex-Grip 550 or Iron-Grip 601 mastic.
 - 2. Hardcast: gypsum-based tape and mastic, waterproof type when used on moist-air exhaust or in humid or outdoor locations.
 - 3. Ductmate: Flanged lateral joints with gaskets.
 - 4. Ductmate: PROseal.
 - 5. Foster: Duct-Fas or Safetee mastic sealant. Duct-Fas is UV resistant and recommended

- for applications exposed to sunlight.
6. Mon-Eco: Eco-Duct Seal 4450 (red color) or 4452 (grey color). Use grey color where ducts will be unpainted and exposed to public view.
 7. Polymer Adhesives Sealant Systems: Airseal No. 11 premium sealant.

2.9 UNIFORMITY OF MATERIALS

- A. Ductwork accessories, including but not limited to volume dampers, smoke dampers, fire dampers, combination fire/smoke dampers, backdraft dampers and motorized dampers, shall be fabricated of materials that are similar to the ductwork in which they are installed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install components furnished under other Section and Divisions of the Specifications. Such items may include but are not limited to: Sensors and airflow measuring stations furnished under Division 23 Section "Instrumentation and Control for Mechanical Systems"; gauges and meters; and smoke detectors furnished under Division 26 – Electrical.
- C. Install ducts in accordance with SMACNA HVACDCS.
- D. Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- E. "Fishmouth" duct connections are not allowed.
- F. Inner tie-rod reinforcement is not allowed. Increase duct sheet metal gauge or external reinforcement as required.
- G. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- H. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- I. Use crimp joints with or without bead for joining round duct sizes 8 inch (200 mm) and smaller with crimp in direction of air flow.
- J. Use double nuts and lock washers on threaded rod supports. Strap hangers shall be minimum 16 gauge (1.50 mm) x 1 inch (25 mm) galvanized straps. Hanger and support components including but not limited to "unistrut" shall be galvanized steel except that where other duct materials are used, the hanger materials shall be compatible and non-corrosive to the duct. Wire hangers are not acceptable.
- K. Flexible Ducts:
 1. Connect diffusers or light troffer boots to low pressure supply ducts directly or with 5 feet (1.5 m) maximum length of flexible duct held in place with strap or clamp.

2. Minimum bend radius shall be one and one half times the duct diameter. Support the bend to maintain this radius.
 3. Bends shall not exceed 45 degrees.
 4. Connect flexible ducts to metal ducts with 2 turns of duct tape and metal draw bands. Plastic drawbands may be used if they are installed using the band manufacturer's lever-action tightening tool. On insulated flexible ducts, provide an additional seal of tape and drawband on the insulation's vapor barrier.
- L. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system. Do not start ducted air moving equipment until construction is completed to a stage where airborne construction dust is no longer present. At the time of substantial completion, the entire air distribution system shall be turned over to the Owner clear of construction dust and debris. If the interior surfaces of any ducted air moving equipment or the interior surfaces of any portion of the ductwork distribution system are found, as determined by the Architect, to contain significant construction dust and debris, the entire air distribution system shall be cleaned in accordance with Division 23. If proper precautions are taken to prevent construction dust and debris from entering the ductwork during construction and if the Architect finds all ductwork to be free from such dust and debris, air duct cleaning shall not be required.
- M. Install duct-mounted components furnished under other Sections of this Specification, such as smoke dampers, control dampers, control sensors, and smoke detectors. Install with straight lengths of duct as required for proper operation. Provide access at such components as required. Install in accessible locations for maintenance; notify the Architect if a location indicated or selected requires addition of access by other trades.

3.2 AIR DUCT LEAKAGE TESTS

- A. Perform air duct leakage tests in accordance with the testing procedures outlined in the latest edition of the SMACNA HVAC Air Duct Leakage Test Manual.
- B. Leakage testing shall be performed on complete new ductwork including fittings and accessories such as dampers, access doors, branch connections, and inlets and outlets. Flexible ducts, VAV boxes, air handling units, and duct coils may be excluded. Ducts may be temporarily sectioned and capped for testing, for reasons of limited test apparatus capacity, or requirements of construction phasing.
- C. Leakage tests, including retests as required, shall be performed prior to concealment and insulation and prior to occupancy.
- D. The Following Duct Systems Shall Be Tested for Leakage, regardless of whether or not SMACNA recommends testing:
1. Supply ductwork starting at connection to existing and to inlets of VAV boxes.
 2. Return ductwork starting at connection to existing to points where ductwork serves fewer than 3 return registers and/or grilles.
- E. Submit testing apparatus, procedures, and preliminary forms prior to performing tests.
- F. Once leakage tests are complete, submit leakage test report. Leakage test report forms shall include the following:
1. Project and system identification data

2. Description of ductwork under test
3. Leakage class specified
4. Test pressure specified
5. Duct construction pressure class
6. Duct design air flow
7. Surface area of ductwork under test
8. Maximum allowable leakage factor
9. Calculated allowable leakage
10. Test apparatus
 - a. Blower
 - b. Orifice, tube size
 - c. Orifice size
 - d. Orifice coefficient
 - e. Calibration date
11. Test orifice differential pressure
12. Leakage for tested section
13. Total leakage for system
14. Date of test
15. Witnesses

G. At a minimum, the first duct leakage test shall be witnessed and approved by the Engineer. At a minimum, subsequent duct leakage tests shall be witnessed and approved by the Engineer or assigned representative. If deficiencies are discovered, they shall be documented. Once deficiencies are corrected, the follow-up leakage tests shall be witnessed.

H. Leakage Class Schedule:

DUCT TYPE	LEAKAGE CLASS
Rectangular Metal	6
Round Metal	3

3.3 SCHEDULES

A. Ductwork Material Schedule

AIR SYSTEM	MATERIAL
Supply, Return, Exhaust	Galvanized Steel

END OF SECTION 233113

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SECTION 233300 – AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Dampers:
 - 1. Fire Dampers.
 - 2. Volume Control Dampers.
- B. Duct Access Doors.
- C. Duct Sleeves, Prepared Openings and Closure Collars.
- D. Duct Test Holes.
- E. Flexible Duct Connections.
- F. Round Duct Branch Taps.
- G. Turning Vanes.

1.2 RELATED SECTIONS

- A. Division 23 Section “Identification for HVAC Piping and Equipment.”
- B. Division 23 Section “Instrumentation and Control for Mechanical Systems.”
- C. Division 23 Section “Metal Ducts.”
- D. Division 26 “Electrical”: Electrical characteristics and wiring connections.

1.3 REFERENCES

- A. ASTM C423-02a - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
- B. ASTM E477-99 - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
- C. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- D. NFPA 70 - National Electrical Code.
- E. SMACNA - HVAC Duct Construction Standards - Metal and Flexible, Third Edition - 2005 (HVACDCS).
- F. SMACNA - Seismic Restraint Manual - Guidelines for Mechanical Systems (SRMGMS).
- G. UL 33 - Heat Responsive Links for Fire-Protection Service.

- H. UL 94 - Safety of Flammability of Plastic Materials for Parts in Devices and Appliances Testing.
- I. UL 555 - Fire Dampers and Ceiling Dampers.
- J. UL 555S - Leakage Rated Dampers for Use in Smoke Control Systems.
- K. UL 1995 - Heating and Cooling Systems.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors and duct test holes.
- C. Product Data: Provide for shop fabricated assemblies including volume control dampers, duct access doors, duct test holes and hardware used. Include electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Indicate for fire dampers and combination fire and smoke dampers.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01.
- B. Record actual locations of access doors and test holes.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years' experience.

1.7 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories Inc., as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01.
- B. Protect dampers from damage to operating linkages and blades.

PART 2 - PRODUCTS

2.1 GALVANIZED STEEL

- A. Steel sheet metal components of accessories in this Specification Section shall be galvanized steel sheet, lock-forming quality, having G60 or heavier zinc coating conforming to ASTM

A653 rating system and tested in accordance with ASTM A90. Provide paint-grip exterior surfaces for exposed ducts, where available.

2.2 DAMPERS

A. Manufacturers:

1. Ruskin.
2. Air Balance, Inc.
3. Arrow.
4. Cesco.
5. Greenheck.
6. NCA.
7. Tamco.
8. Ventex.
9. Vent Products, Inc.
10. No substitutions.

B. Fire Dampers:

1. Fabricate in accordance with NFPA 90A and UL 555, and as specified or as indicated on the Drawings.
2. Fire Dampers Other Than Ceiling Dampers:
 - a) For systems in which the fan does not stop immediately in a fire or smoke alarm condition, requiring the damper to close against airflow, dynamic-closure type dampers are required by NFPA 90A:
 - 1) Fire dampers shall be of the dynamic closure type, shall have been successfully tested to UL Standard 555 - 6th Edition as to their ability to close under dynamic airflow conditions and shall bear the UL label stating that they are suitable for that application. Static fire dampers designed to operate with no airflow in the ductwork shall not be acceptable. Dynamic closure fire dampers shall have been successfully tested in both horizontal and vertical mounting positions to close against a velocity of 2,400 fpm (12.2 m/s) and a static pressures of 4.5 in. w.g. (1.12 kPa).
 - 2) Multiple Blade Dampers: Galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, plated steel concealed linkage, stainless steel closure spring, and blade stops. Dampers shall be dual-directional airflow rated for ease of installation.
 - a) For applications requiring a 1-1/2-hour rated damper, at operating velocities up to 1,500 fpm (7.6 m/s) and fan or air handler external static pressures up to 2 in. w.g. (0.5 kPa), fire dampers shall be equal to Ruskin DFD35, with vee-groove reinforced formed blades, rated for 2,000 fpm (10.1 m/s) and 4 in. w.g. (1.0 kPa) maximum. Pressure drop at 1,000 fpm (5.08 m/s) in a 24 in. x 24 in. (600 x 600 mm) damper shall not exceed 0.07 in. w.g. (17.5 Pa).
 - b) For applications where required fire rating, velocity, or static pressure is higher (and at lower-rated locations at the Contractor's option), dampers shall be equal to Ruskin DFD60, airfoil-shaped blades, rated for 4,000 fpm (20.3 m/s) and 8 in. w.g. (2.0 kPa) maximum, 1-1/2-hour or 3-hour rated as required. Pressure drop at 1,000 fpm (5.08 m/s) in a 24 in. x 24 in. (600 x 600 mm) damper shall not exceed 0.03 in. w.g. (7.5 Pa).

- c) Damper linkage shall be capable of being held open with a pair of hand pliers while the fusible link is replaced during testing.
 - 3) Curtain-Type Dampers: For use in easy-access locations directly behind grilles and registers or open-ended ducts ONLY. Type B with blades out of the air stream. Provide thinline type where required. Galvanized steel with interlocking blades. Stainless steel closure springs.
 - b) Submittals shall include a schedule of damper locations indicating size, design airflow, design airflow face velocity, system external static pressure, and fire rating of the building assembly, with selected damper model, accompanied by damper and accessory data sheets and manufacturer's installation instructions. If only one model of damper is required, submittals may be simplified accordingly.
 - c) Dampers may be furnished with factory sleeves (verify length and gage), retaining angles, and breakaway connections at the Contractor's option.
 - d) Dampers for Out-of-Wall or Out-of-Floor Installation: Provide factory assembly including damper, sleeve, and factory-installed fire-retardant insulation.
 - 3. Fusible Links: UL 33, separate at 165 degrees F (100 degrees C) with adjustable link straps for combination fire/balancing dampers. Provide links melting at 212 degrees F (100 degrees C) within 50 feet (15.2 m) downstream of heating coils.
 - a) Mounting shall either be the flat-strap type requiring no tools to bend the straps for removing the link, or shall use standard threaded hex-nut fastening. Fastening with heavy-gauge wire hooks or other methods requiring difficult bending are not allowed.
 - b) Links shall be Nailor Industries Easy Maintenance Link (EML) or equal. Accessible from either side of the damper. Allows for releasing, testing, and relatching of blades with one hand.
 - 4. Testing and Access: See Part 3 of this Section for requirements for field testing of each damper, and associated access doors. Provide replacement fusible links as required. During testing, furnish means for holding dampers open while fusible link is reset.
- C. Volume Control Dampers:
 - 1. Factory-fabricate in accordance with SMACNA HVACDCS, and as specified or as indicated on the Drawings.
 - 2. Shop fabrication is permitted for single blade dampers only.
 - 3. Height is the dimension perpendicular to the blade rod or shaft. Width is the dimension parallel to the blade rod.
 - 4. Single Blade Dampers: For duct sizes (height x width) up to 7 x 30 inch (175 x 760 mm). When height or width exceeds its respective maximum, provide multi-blade damper.
 - 5. Multi-Blade Damper: Opposed blade pattern with maximum blade sizes (height x width) 8 x 72 inch (200 x 1825 mm). Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
 - 6. End Bearings: Except in round ductwork 6 inches (150 mm) and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings. Provide retainer clips or other devices to prevent bearings from pulling out. For single-blade dampers, plastic bearings are allowed.
 - a) Manufacturers:
 - 1) Duro Dyne.
 - 2) Elgen Manufacturing.
 - 3) Rossi.
 - 4) Ventfabrics.
 - b) Snap-in Plastic Bearings for Single-Blade Dampers: Designed to push into hole in sheet metal, with retaining tabs. Flame Retardant, Glass Reinforced, "Zytel"

polymer by Dupont, conforming to UL 1995 and UL 94 with the required flammability rating of 5VA or lower. Acceptable materials include Polyamide 66 (PA66) (glass-reinforced Dupont Zytel), nylon and acetyl. Submit manufacturer's verification of the suitability of these bearings for the application, including operating pressures and temperatures.

7. Quadrants:
 - a) Manufacturers:
 - 1) Duro-Dyne.
 - 2) Elgen Manufacturing.
 - 3) Ventfabrics.
 - b) Duro-Dyne Specline SR and SRH series; Quadline series; or Stampline dial regulators and wedge-loc regulators. Or equal by Elgen, or Ventfabrics. Factory-manufactured dampers shall have damper manufacturer's choice of quadrant equal to the Duro-Dyne products specified.
 - c) Provide locking, indicating quadrant regulators on single and multi-blade dampers. Regulators shall include lever handle, locking wing nut and graduated indicator dial. Provide shaft seals, bushings, or gaskets for duct penetrations. Quadrants without these features are not allowed.
 - d) On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters, with open space to run insulation through.
 - e) Where rod lengths exceed 30 inches (750 mm) provide regulator at both ends, with a single rod so that either regulator will control the entire damper.
8. Provide required operating wrenches for balancing, and furnish to the Owner at project completion.

2.3 CASINGS AND PLENUMS

- A. Factory fabricate components with field installation. The plenum or casing manufacturer shall provide certified testing data, obtainable directly from an independent acoustical laboratory, listing sound absorption and transmission loss characteristics of panel assembly. Sound absorption coefficients and sound transmission loss, determined by an independent laboratory, shall be in accordance with ASTM C 423 and ASTM E 90 respectively.

2.4 DUCT ACCESS DOORS

- A. Manufacturers:
 1. Standard Doors:
 - a) Ruskin.
 - b) Air Balance, Inc.
 - c) Arrow.
 - d) Buckley Associates.
 - e) Cesco.
 - f) DuctMate.
 - g) Greenheck.
 - h) Nailor.
 - i) Vent Products, Inc.
 - j) Shop fabricated.
 2. Medium and High-Pressure Doors:
 - a) Ruskin.
 - b) DuctMate.
 - c) Greenheck.

- d) Nailor.
 - e) No substitutions.
- B. Fabricated in accordance with SMACNA HVACDCS, and as specified or as indicated on the Drawings. Standard access doors and access doors for grease ducts may be shop-fabricated. Pressure rating shall be equal to the rating of the associated ductwork; see Part 3 Division 23 Section "Metal Ducts" for schedule of pressure classes.
- C. Standard Doors: Removable, with retainer chain. Rigid and close-fitting with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum 1 inch (25 mm) thick insulation with galvanized steel sheet metal airstream-side cover.
- 1. 16 inches (406 mm) Square and Smaller: Secure with two sash locks.
 - 2. Over 16 inches (406 mm), up to 24 inches (610 mm) Square: Provide four sash locks.
 - 3. Larger Sizes: Hinges and two compression latches with outside and inside handles.
 - 4. Clamping-type doors with knob handles, as manufactured by Ductmate, may be substituted for standard sizes.
 - 5. Material: Galvanized steel in galvanized steel ductwork. Stainless steel in stainless steel ductwork. Aluminum as manufactured by Arrow in aluminum ductwork.
 - 6. Provide in negative-pressure systems, and in positive-pressure systems with specified pressure class at or below 2 in. WG (498 Pa).
- D. Medium- and High-Pressure Positive-Pressure Ducts:
- 1. Ruskin ADHP-3 high pressure access door rated up to 12 in. WG (2985 Pa), with spring latches to allow the door to open temporarily to relieve negative pressures.
 - 2. Provide in positive-pressure systems with specified pressure class above 2 in. WG (498 Pa).
- E. Access doors with sheet metal screw fasteners are not acceptable.
- F. Sizing: Select sizes to allow testing, service, and maintenance within the ductwork. Such access may require the insertion of one or both hands, arms, and shoulders as appropriate. Doors sized for viewing-only are not acceptable. Doors found to be of inadequate size shall be replaced with proper size.

2.5 DUCT SLEEVES, PREPARED OPENINGS AND CLOSURE COLLARS

- A. Duct Sleeves and Closure Collars: Fabricate from minimum 20 ga (1.0 mm) galvanized steel or equivalent thickness of aluminum, select material to match duct material. Where sleeves are installed in bearing walls, provide structural steel sleeves.
- B. Prepared Openings: Provide 1 inch (25.4 mm) clearance between the duct and the sleeve.

2.6 DUCT TEST HOLES

- A. Manufacturers:
- 1. Ductmate.
 - 2. Carlyle Corporation.
 - 3. Duro-Dyne.
 - 4. Ventfabrics.
- B. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene

plugs, threaded plugs, or threaded or twist-on metal caps.

- C. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.7 FLEXIBLE DUCT CONNECTIONS

- A. Manufacturers:
 - 1. Ductmate.
 - 2. Ventfabrics.
 - 3. Duro-Dyne.
 - 4. No substitutions.
- B. Fabricate in accordance with SMACNA HVACDCS, and as specified or as indicated on the Drawings.
- C. Connector: Fabric crimped into metal edging strip.
 - 1. Connectors shall be Ductmate PROFLEX Commercial series.
 - 2. Fabric: UL listed coated woven glass fiber fabric meeting the requirements of NFPA 90A and NFPA 701. Resistant to weather and most chemicals, fat, grease, and oil.
 - a) Supply Ducts: Neoprene coated, minimum density 30 oz per sq yd (1.0 kg/sq m). Fire-retardant coating. Black color. Temperature range -40 to 200 degrees F (-40 to 93 degrees C).
 - b) Exhaust Ducts Serving Fume Hoods: Hypalon coated, minimum density 24 oz per sq yd (0.8 kg/sq m). Flame proof coating. White color. UV and ozone resistant. Temperature range -40 to 250 degrees F (-40 to 121 degrees C).
 - 3. Net Fabric Width: Approximately 3 inches (75 mm) wide.
 - 4. Metal: 3 inch (75 mm) wide, 24 ga (0.6 mm thick).
 - a) Supply Ducts: G-60 galvanized steel.
 - b) Exhaust Ducts Serving Fume Hoods: Type 316 stainless steel.
 - 5. Connectors shall have double fold seams. Single fold seams (metal folded once only) shall not be accepted.
- D. Leaded Vinyl Sheet: Minimum 0.55 inch (14 mm) thick, 0.87 lbs per sq ft (4.2 kg/sq m), 10 dB attenuation in 10 to 10,000 Hz range.

2.8 ROUND DUCT BRANCH TAPS AND SPIN-IN FITTINGS

- A. Saddle Taps: For round ducts branching off main ducts at 90 degrees, provide factory fabricated, saddle-tap fittings with conical or bellmouth taps, or 45 degree rectangular-to-round branch fittings. For round ducts branching off at 45 degrees, fittings do not require conical or bellmouth expansion. Fittings shall be furnished with flange for fastening and sealing designed to overlap onto adjacent duct, and shall be shaped to fit tight to the exterior of the duct, flat for rectangular duct, curved for round duct.
- B. Spin-in fittings, factory-fabricated with conical or bellmouth taps are an acceptable substitute for saddle taps.
- C. Factory-fabricated taps and spin-ins may be furnished with integral volume dampers and quadrants as specified in paragraph "Manual Dampers" in this Section.

2.9 TURNING VANES

- A. Manufacturers for Turning Vanes and Vane Rails:
 - 1. Ductmate Industries - PROrail 2 inch Turning Vane Rail.
 - 2. Duro Dyne - Junior Vane Rail.
 - 3. Hardcast, a division of Carlisle Corporation - Dyn-O-Rail Jr.
- B. Factory-fabricated and factory-or-field-assembled units consisting of curved turning vanes for uniform air distribution and change of direction with minimum turbulence and pressure loss. Provide curved single thickness vanes for mitered elbows with change in direction of 45 degrees or greater, conforming to SMACNA HVACDCS single vane schedule for small vanes. Each vane shall form a 90 degree arc. Fill the entire duct cross-section with vanes. Orient leading edge of vanes parallel to the side of the duct (directed straight into the entering airstream).
- C. Turning vanes shall be minimum 16 gauge (1.61 mm), regardless of gauges that are recommended by SMACNA. Double thickness turning vanes are not allowed.
- D. Turning vanes in rectangular ductwork and shop-fabricated round ductwork shall conform with details on the Drawings. If not detailed, the SMACNA detail for small-radius small-spacing single-thickness vanes shall be used.
- E. Turning vanes in manufactured round and flat oval duct elbows shall be the duct manufacturer's standard size, spacing, and gauge, but must be single-wall and not less than 16 gauge (1.61 mm).
- F. Factory-fabricated turning vane rails shall be a minimum of 24 ga (0.7 mm) galvanized steel.
- G. Material for vanes and rails shall be the same as the duct sheet metal.

2.10 UNIFORMITY OF MATERIALS

- A. Ductwork accessories, including but not limited to volume dampers, smoke dampers, fire dampers, combination fire/smoke dampers, backdraft dampers and motorized dampers, shall be fabricated of materials that are similar to the ductwork in which they are installed.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVACDCS. Refer to Division 23 Section "Metal Ducts" for duct construction and pressure class.
- B. Install components furnished under other Section and Divisions of the Specifications. Such items may include but are not limited to: Sensors and airflow measuring stations furnished under Division 23 Section "Instrumentation and Control for Mechanical Systems"; gauges and meters; and smoke detectors furnished under Division 26 – Electrical.

- C. Provide duct access doors for inspection, servicing, and cleaning before and after coils, before automatic dampers, at fire dampers, at smoke dampers, at smoke detector sampling tubes (upstream of the sampling tube), at multiple blade volume dampers, and elsewhere as specified or as indicated on the Drawings. Review locations prior to fabrication.
- D. Access doors installed for access to fire dampers and fire/smoke dampers shall be provided with identification with letters of minimum 1/2 inch (13 mm) height to indicate the presence of fire protection devices within. Conform with NFPA 90A and applicable Codes. Refer to Division 23 Section "Identification for HVAC Piping and Equipment" for labeling materials specifications.
- E. Provide fire dampers at locations indicated, where ducts and outlets pass through fire rated components. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- F. Fire Damper Testing: Demonstrate operation and re-setting of each fire damper and fire/smoke damper to Owner's representative after installation and prior to building occupancy. Remove or melt the fusible link and allow the damper to close, then reopen the damper and replace the link. Repair or replace any damper which doesn't close and open properly. Coordinate with access door installation to ensure that access doors are of adequate size and location to allow required reach with 2 hands to hold the damper open while replacing the link.
- G. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- H. Provide balancing dampers on duct take-offs to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly. Where branch duct is completely above non-accessible wallboard ceiling and the Architect has not approved the use of access doors, duct mounted balancing dampers shall not be required.
- I. For volume dampers located above suspended ceilings and in areas that are not visible to building occupants (e.g. mechanical rooms), provide fluorescent orange colored surveyor's tape. Permanently attach tape to damper handles and run tape down to 10 in. (254 mm) above ceiling or 12 in. (304 mm) below damper handle where ceilings do not exist (e.g. mechanical rooms).
- J. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment, and support by vibration isolators. Staple and seal connections airtight. Duct Sleeves and Prepared Openings: Install for ducts passing through roofs, ceilings, walls and floors. Field determine the proper size and location of sleeves and prepared openings.
 - 1. Duct Sleeves: Allow one-inch (25 mm) clearance between duct and sleeve or one-inch (25 mm) clearance between insulation and sleeve for insulated ducts, except at grilles, registers, and diffusers.
 - 2. Prepared Openings: Allow one-inch (25 mm) clearance between duct and opening or one-inch (25 mm) clearance between insulation and opening for insulated ducts, except at grilles, registers, and diffusers.
- K. Closure Collars:
 - 1. Provide not less than 4 inches (100 mm) wide on each side of walls or floors where sleeves or prepared openings are installed. Fit collars snugly around ducts. Grind smooth edges of collar to prevent tearing or puncturing insulation covering or vapor

- barrier.
2. Where insulated ducts penetrate non-fire-rated walls, insulation shall be continuous through the closure collars and the closure collars shall be installed tight to the insulation.
 3. Where insulated ducts penetrate fire rated walls, insulate ducts on both sides of closure collars and seal points of contact between closure collar and insulation with vapor proof adhesive.
 4. Where ducts penetrate fire rated walls, provide fire proof sealant at closure collar.
 5. Secure closure collars to ducts with sheet metal screws at maximum 6 inch (152 mm) centers and secure closure collars to walls or floors with sheetrock screws, nails or other appropriate fastener at maximum 6 inch (152 mm) centers.
 6. Packing: Pack with non-combustible glass fiber insulation in spaces between sleeve/opening and duct/duct insulation. Cover or seal edges of packing to contain loose fibers.
- L. Duct Hangers and Supports: SMACNA HVACDCS, Section 4. Hang ducts up to and including 36 inches (914 mm) in width by a minimum of 1 in x 16 ga (25 mm x 1.61 mm) flat straps on each side of the duct on 4 ft (1.22 m) centers, bent under bottom of duct a minimum of 2 inches (50 mm) and securely fastened to duct. Hang ducts larger than 36 inches (914 mm) in width by 3/8 inch (9.5 mm) steel rods and 2 x 2 x 1/4-inch (50x50x6.3 mm) steel angle trapeze hangers, spaced 4 ft (1.22 mm) on center. Anchor risers in the center of the vertical run to allow ends of riser free vertical movements. Attach supports only to structural framing members and concrete slabs. Do not anchor supports to metal decking unless a means is provided and approved for preventing the anchors from puncturing the metal decking. Where supports are required between structural framing member, provide suitable intermediate metal framing. Where C clamps are used, use retainer clips.
1. Flexible Ducts: Support ducts by hangers every 3 feet (0.9 m), unless supported by ceiling construction. Stretch flexible air ducts to smooth out corrugations, and long radius elbows, where possible, using a minimum length to make connections.
 2. Flexible Connectors: Provide flexible connectors between fans and ducts or casings and where ducts are of dissimilar metals. For round ducts, securely fasten flexible connectors by zinc-coated steel clinch-type draw-bands. For rectangular ducts, lock flexible connectors to metal collars.
- M. Provide duct test holes where indicated and required for testing and balancing purposes.
- N. Provide interconnecting power and control wiring as required, in accordance with Division 26.

END OF SECTION 233300

SECTION 233700 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Diffusers.
- B. Registers/Grilles.

1.2 RELATED SECTIONS

- A. Division 09 Section for painting: Painting of ductwork visible behind outlets and inlets.

1.3 REFERENCES

- A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
- B. ADC 1062 - Certification, Rating and Test Manual.
- C. AMCA 500 - Test Method for Louvers, Dampers and Shutters.
- D. AMCA 511 - Certified Ratings Program for Air Control Devices
- E. ARI 650 - Air Outlets and Inlets.
- F. ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Outlets and Inlets.
- G. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- H. ASTM E413 - Classification for Rating Sound Insulation.
- I. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
- J. NFPA 70 - National Electrical Code.
- K. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01 Section "Submittal Procedures."
- B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets indicating type, size, application, rated airflow, noise level, pressure drop, and throw distance as applicable. Submit both manufacturer's standard performance tables and graphs, AND tabulated selection data specific to this project. NOTE: Submittals without complete and sufficient information, to verify the performance specified and scheduled on the Drawings, shall be rejected.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01 Section "Closeout Procedures."
- B. Record actual locations of air outlets and inlets.

1.6 QUALITY ASSURANCE

- A. Test and rate air outlet and inlet performance in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.
- B. Test and rate louver performance in accordance with AMCA 500.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum 3 years' experience.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Diffusers, Registers, Grilles:
 - 1. Titus.
 - 2. Anemostat.
 - 3. Krueger.
 - 4. Metalaire.
 - 5. Price.
 - 6. No substitutions.

2.2 PERFORATED SECURITY GRILLES AND DIFFUSERS

- A. Type: Fixed grilles of perforated face with 3/16 inch (4.8 mm) diameter holes on 9/32 inch (7.1 mm) staggered centers. Grilles shall comply with the National Institute of Corrections guidelines for suicide prevention.
- B. Frame: 1-1/2 inch (38.1 mm) margin with no fasteners on the exposed face.
- C. Fabrication: Faceplate and sleeve shall be 3/16 inch (4.8 mm) thick steel. Sleeve shall be stitch-welded to the face and along seams. Factory finish shall be off-white baked enamel.
- D. Shipped-loose angle mounting frame shall be 1-1/2 x 1-1/2 inch (38.1 x 38.1 mm) 3/16 inch (4.8 mm) thick steel, with mill finish.
- E. Length of integral shall be as required to pass completely through the thickness of the architectural building assembly to which the grille is mounted.
- F. Damper: None.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.
- C. Install outlets and inlets to ductwork with air tight connection.
- D. Paint ductwork visible behind air outlets and inlets matte black. Refer to Division 09 Section for painting.
- E. Surfaces exposed to view shall be clean, and free of stains, smudges, and scratches.

END OF SECTION 233700

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SECTION 235700 – HEAT EXCHANGERS FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Brazed plate type heat exchangers.
- B. Accessories and trim.

1.2 RELATED SECTIONS

- A. Division 23 Section “Hydronic Piping.”
- B. Division 23 Section “Hydronic Specialties.”
- C. Division 23 Section “Steam and Condensate Heating Piping.”
- D. Division 23 Section “Steam and Condensate Heating Specialties”
- E. Division 23 Section “Instrumentation and Control for Mechanical Systems.”

1.3 REFERENCES

- A. ANSI/ASME - Boilers and Pressure Vessels Code.

1.4 REGULATORY REQUIREMENTS

- A. Conform to Section 8D of the ANSI/ASME Boilers and Pressure Vessels Code for manufacture of tubular heat exchangers and heat exchanger shells.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years’ experience.

1.6 SUBMITTALS

- A. Submit Shop Drawings and product data under provisions of Division 01 Section “Submittal Procedures.”
- B. Indicate dimensions, locations, and size of tappings and performance data.
- C. Submit manufacturer's installation instructions.
- D. Submit design data in sufficient detail to verify that heat exchangers meet or exceed specified requirements.

- E. Submit test reports of tube bundle pressure tests.

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Division 01.
- B. Include start up and shut down instructions, assembly drawings, and spare parts lists.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Division 01 Section "Product Requirements."
- B. Store and protect products under provisions of Division 01 Section "Product Requirements."
- C. Protect internals from entry of foreign material by temporary caps on flanged openings.

PART 2 - PRODUCTS

2.1 PLATE TYPE HEAT EXCHANGERS – BRAZED TYPE

- A. Manufacturers:
 - 1. Taco.
 - 2. Armstrong.
 - 3. Bell & Gossett.
 - 4. APV.
- B. Plates: Embossed with a specific heat transfer surface. Stainless steel Type 316.
- C. Brazing Alloy: 99 percent copper.
- D. Nozzles: Male NPT thread, stainless steel Type 316.
- E. Mounting Studs: Threaded stainless steel Type 316, brazed or welded to outer plate.
- F. Maximum Working Pressures and Temperatures:
 - 1. Pressure: 435 psig (3000 kPa) (30 bar).
 - 2. Temperature: 350 degrees F (176 degrees C).
- G. U.L. Listed. (ASME Certified with permanent metal ASME stamp or nameplate.)

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Support heat exchanger from structure above with spring isolation hangers.

- C. Pitch shell to completely drain condensate.
- D. Pipe relief valves to nearest floor drain.
- E. Pipe drain valves to nearest floor drain.

3.2 STEAM TO WATER HEAT EXCHANGER TRIM

- A. Shell: Pressure gauge tapping with pigtail siphon, vacuum breaker.
- B. Water Inlet: Thermometer well, pressure gauge tapping, valved drain.
- C. Water Outlet: Thermometer well for temperature regulator sensor, ASME rated pressure relief valve, thermometer well, pressure gauge tapping.

END OF SECTION 235700

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SECTION 237413 – PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Packaged rooftop air handling units.
- B. Refrigeration Components.
- C. Unit controls.
- D. Maintenance service.

1.2 RELATED SECTIONS

- A. Division 23 Section “Motors, Drives and Accessories.”

1.3 REFERENCES

- A. ARI 210 - Unitary Air-Conditioning Equipment.
- B. ARI 240 - Air Source Unitary Heat Pump Equipment.
- C. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
- D. ARI 360 - Unitary Air-Conditioning Equipment.
- E. ARI 370 - Sound Rating of Large Outdoor Refrigerating and Air Conditioning Equipment.
- F. ANSI/ASHRAE 90A - Energy Conservation in New Building Design
- G. NFPA 70 - National Electrical Code.
- H. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Shop Drawings: Indicate capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.
- C. Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.
- D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing. Submit in accordance with Division 01.

1.5 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum 3 years' experience.

1.6 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., as suitable for the purpose specified and indicated.
- B. Unit shall conform to UL 1995/CSA 22.2 #236 for construction of packaged air conditioner and shall have UL/CSA label affixed to rooftop package.
 - 1. In the event the unit is not UL/CSA approved, the manufacturer shall, at his expense, provide for a field inspection by a UL/CSA representative to verify conformance to UL/CSA standards. If necessary, contractor shall perform required modifications to the unit to comply with UL/CSA, as directed by the UL/CSA representative, at no additional expense to the Owner.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. See Division 01: Transport, handle, store, and protect products.
- B. Protect units from physical damage by storing off site until roof mounting curbs are in place, ready for immediate installation of units.

1.8 WARRANTY

- A. Provide a full parts warranty for 1 year from substantial completion.
- B. Provide 5 year extended warranty for compressors including materials only.

1.9 MAINTENANCE SERVICE

- A. See Division 01.
- B. Furnish service and maintenance of packaged roof top units for 1 year from Date of Substantial Completion.
- C. Provide maintenance service with a 2 month interval as maximum time period between calls. Provide 24-hour emergency service on breakdowns and malfunctions.
- D. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of 6 filter replacements, minimum of 1 fan belt replacement, and controls check-out, adjustments, and recalibration.
- E. Submit copy of service call work order or report, and include description of work performed.

1.10 ACOUSTICS

- A. Manufacturer of packaged rooftop equipment shall provide indoor and outdoor sound power level data across major octave band center frequencies for cataloged operating range of unit at gross cooling capacity range. Data shall be obtained in conformance with ANSI S1.32-1980,

American National Standard Methods for the Determination of Sound Power Levels of Discrete Frequency and Narrow Band Noise Sources in Reverberation Rooms and per AMCA Standard 300-85 test code "Sound Rating Air Moving Devices".

1.11 EXTRA MATERIALS

- A. See Division 01.
- B. Provide 1 set of filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Daikin Applied (formerly McQuay).
- B. Trane.
- C. York/JCI.
- D. No substitutions.

2.2 PACKAGED ROOFTOP OUTDOOR UNITS

- A. General Unit Description:
 - 1. Units shall be packaged rooftop-type air handling units as indicated on the Drawings and within these Specifications. Cooling capacity ratings shall be based upon ARI Standard 360. Unit(s) shall consist of insulated weathertight casing with hinged access doors, compressors, air cooled condenser coil, condenser fans, evaporator coil, filters, heating section, supply and exhaust fans with motors and drives, dampers, and unit controls.
 - 2. Unit(s) up to 52 feet (15.8 m) long shall be single-piece construction as manufactured at the factory. Site assembled sub- assemblies will not be allowed. Packaged units shall be constructed for installation on a roof curb providing full perimeter support under air handler section and pedestal support under condenser section.
 - 3. Unit(s) shall be factory run tested to include the operation of fans, compressors, heat exchangers, and control sequences.
 - 4. Unit(s) shall have labels, decals, and/or tags to aid in the service of the unit and indicate caution areas.
- B. Unit Casing:
 - 1. Cabinet: Galvanized steel, phosphatized, and finished with base primer and polyester resin topcoat in neutral beige or grey color, durable enough to withstand 750-hour salt spray test in accordance with standard ASTM B 117. Base frame shall be constructed of pre-painted galvanized steel, in heavy gauges designed to fully support the unit with only perimeter curb or grillage support. Structural members and exterior panels shall be designed to operate at internal static pressures up to 5.5 in. wg (1.37 kPa). Inner liners shall be 22 gauge minimum thickness. Roof panels shall be sloped to provide positive drainage of rain water / melting snow away from the cabinet.

2. Access Doors: Fully gasketed hinged doors of double wall construction with quick-release lever or knob fasteners, safety catches, and door holders or and chained tie-backs to provide access to filters, evaporator coil, heating section, heating valves, fan sections, and control panels.
3. Control Panel: The unit control panel section shall be compartmented to separate high and low voltage components.
4. Insulation: Provide 2-inch (100 mm) thick 1-1/2 lb/cu.ft (24 kg/m³) density, R-6.5 h-ft²-°F/Btu (R=1.14 K-m²/W) airstream-coated fiberglass internal liner on exterior and floor panels in contact with the conditioned air stream.

C. Fans – Supply:

1. Forward curved or airfoil fans as scheduled on the Drawings, with fixed-pitch sheave drive assemblies. Fans shall be Class II type (unless otherwise scheduled on the Drawings), fabricated from heavy-gauge aluminum.
2. Dynamically balance fans and the unit's running fan assembly (fan mounted on actual shaft, bearings and in scroll housing) to assure smooth operation of the fan and its associated assembly. Balancing of the fan only shall not be acceptable.
3. Mount fan motor(s) and fan on a common base assembly and isolated from unit with spring isolators with seismic restraints. Provide thrust restraint isolation on the fan housing/fan board to assure smooth fan startup transition and operation.
4. Fan shaft shall be mounted on grease lubricated ball bearings, sized to provide L-50 life of 200,000 hours.
5. Motor shall be open drip-proof. Motor shall have a standard T-frame and a minimum service factor of 1.15. Drive components shall be accessible without the use of scaffolds or ladders, to facilitate periodic maintenance checks and for operator safety.
6. Each fan drive shall have a minimum of 2 belts.

D. Fans – Exhaust:

1. Propeller axial fans, with variable-pitch sheave drive assemblies. Fans shall be fabricated from steel. Fans shall be statically and dynamically balanced.
2. Fan shaft shall be mounted on grease lubricated ball bearings, sized to provide L-10 life of 100,000 hours.
3. Motor shall be open drip-proof. Motor shall have a standard T-frame and a minimum service factor of 1.05. Drive components shall be accessible without the use of scaffolds or ladders, to facilitate periodic maintenance checks and for operator safety.
4. Each fan drive shall have a minimum of 2 belts.
5. Isolation including springs and flexible duct connections shall comply with Division 23 Section “Vibration and Seismic Controls for HVAC Piping and Equipment.”
6. Exhaust fan section shall have an expanded metal belt guard if belt driven.

E. Refrigeration System:

1. Each unit shall have 2 independent refrigeration circuits. Each circuit shall include low pressure control, filter-drier, liquid moisture indicator / sight glass, solenoid, thermal expansion valve, liquid line shutoff valve with charging port, discharge line shutoff valve, manual reset high pressure safety switch, and high pressure relief device. The thermal expansion valves shall provide modulation from 100 percent to 25 percent of rated capacity. Sight glasses shall be accessible for viewing during unit operation.
2. Each circuit shall be dehydrated and leak tested.
3. Compressors: Multiple heavy-duty scroll type. Compressors shall have crankcase heaters, oil sight glass, anti-slug protection, current and motor temperature sensing, and

motor overload protection. Provide time delays to prevent short cycling and prevent simultaneous starting after a power failure.

4. Capacity control shall be accomplished by staging of the unit's multiple compressors. Staging shall be controlled by the factory-installed main unit control system.
 5. Provide reheat coil with modulating hot gas reheat, piped to the lead compressor circuit with modulating valves, micro-channel refrigerant reheat coil, and dehumidification control. Controls shall maintain +/- 0.5 degrees F (0.28 degrees C) control of the reheat coil leaving air temperature.
- F. Condenser Section:
1. Provide multi-row cast aluminum micro-channel coils, V-bank configuration, recessed so that cabinet panels provide hail protection. Factory leak-test coils with high-pressure air under water.
 2. Provide vertical discharge, direct drive fans with steel blades, and 3-phase motors. Fans shall be statically and dynamically balanced. Motors shall be permanently lubricated, with built-in current and thermal overload protection and rain shields.
 3. Each circuit shall have fan cycling control on at least 1 condenser fan, controlled to maintain positive head pressure. An ambient thermostat shall prevent the refrigeration system from operating below 45 degrees F (7.2 degrees C).
- G. Evaporator Coil Section:
1. Coil with seamless copper tubing mechanically expanded into aluminum plate fins. Coil circuiting shall be interlaced to maintain full active coil face area at part load conditions. Coil shall be factory leak tested with high pressure air under water.
 2. Provide pitched stainless steel drain pan to assure positive drainage of condensate from the unit casing. Units with stacked cooling coils shall have a secondary drain pan piped to the primary drain pan.
- H. Hot Water Heating Section:
1. Coil with heavy-duty aluminum fins mechanically bonded to seamless copper tubes. Factory leak test coil with high-pressure air under water.
 2. Coil vents and drains shall be factory-installed.
 3. The unit cabinet shall include access doors/panels providing access to the coil and valves for inspection and cleaning.
- I. Outdoor Air Section:
1. Provide 100 percent outside air hood at the inlet to the filter section. Hood shall include a bird screen and rain lip.
 2. Dampers shall be Daikin UltraSeal low-leak opposed-blade dampers with full blade gasketing and end seals, for leakage of less than 0.2 percent at 1.5 in. wg (374 Pa) static pressure differential, tested in accordance with AMCA Standard 500.
 3. Damper actuators shall be modulating, spring-return type. Separate actuators shall be provided for outside air and return air to allow independent control of each damper.
- J. Air Filter Housing: Filters shall mount integral within unit casing and be accessible via hinged access doors. Provide steel or aluminum filter tracks, metal holding frame for each filter, and corrugated metal filler panels to prevent air bypassing filters. Filter access doors shall have compressible gasketing or elastomeric foam insulation to seal tight against the ends of the filters.
1. Air Filters: Filters shall be 2 inch (50 mm) thick MERV 8 disposable pleated-media extended-area panel filters in metal holding frames.

2. Accessories:
 - a. Filter Gauges: Dwyer Magnahelic filter gauges to read pressure drop across filters. Gauges shall be factory-mounted in exterior unit panels.
- K. Energy Recovery Section:
 1. Unit shall include an ARI certified energy recovery enthalpy wheel.
- L. Miscellaneous Features:
 1. Non-fused disconnect switch.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. See Division 01: Verification of existing conditions prior to beginning work.
- B. Verify that roof is ready to receive work, and opening dimensions are as indicated on Submittals.
- C. Verify that proper power supply is available.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NFPA 90A.
- C. Mount units on structural steel roof grillage, providing watertight curbs and flashing enclosures to protect ductwork and utility services. Install and shim unit level.
- D. Bolt units in place with galvanized steel hex-head bolts and washers at each factory mounting hole, with fasteners' diameter as large as the factory holes allow. Protect dissimilar metals from contact.
- E. Electrical connections shall be flexible in accordance with Division 26 – Electrical.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Prepare and start systems under provisions of Division 01.
- B. Provide initial start-up and shut-down during first year of operation, including routine servicing and check-out.
- C. Manufacturer shall furnish a factory trained service engineer without additional charge to start the unit. Packaged rooftop unitary manufacturers shall maintain service capabilities no more than 100 miles (161 km) from the jobsite.

END OF SECTION 237413

SECTION 238126 - VRV AC SYSTEM

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

- A. Variable capacity, variable refrigerant flow heat recovery and air conditioning split systems.
- B. The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label.
- C. All wiring shall be in accordance with the National Electric Code (NEC).
- D. The system will bear the Energy Star label.
- E. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.

1.2 DELIVERY, STORAGE AND HANDLING

- A. Units shall be stored and handled according to the manufacturer's recommendations.

PART 2 - WARRANTY

2.1 WARRANTY

- A. The units shall have a manufacturer's warranty for a period of one (2) years from date of installation. The units shall have a limited labor warranty for a period of one (2) years from date of installation. During the stated period, should any part fail due to defects in material and workmanship, it shall be repaired or replaced at the discretion of the Manufacturer.

PART 3 - PRODUCTS

3.1 ACCEPTABLE MANUFACTURERS

- A. The following Manufacturers are acceptable:
 - 1. Daikin.
 - 2. No substitutions.

3.2 INDOOR UNITS

- A. General: The indoor unit is designed specifically for use with the existing VRV energy recovery system currently installed.
 - 1. The indoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls.
 - 2. Both liquid and suction lines must be individually insulated between the indoor unit and existing refrigerant lines.

- B. Indoor Unit:
1. The indoor units shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
 2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
 3. Both refrigerant lines shall be insulated from the outdoor unit.
 4. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 21” of lift.
 5. The indoor units shall be equipped with a return air thermistor.
 6. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
 7. The voltage range will be 253 volts maximum and 187 volts minimum.
- C. Control:
1. The unit shall have controls provided by the Manufacturer to perform input functions necessary to operate the system. The unit shall have stand-alone control but include provisions for interfacing with a BMS in the future.
 2. The unit shall be compatible with interfacing with connection to LonWorks networks or interfacing with connection to BMS system. Consult with Manufacturer prior to applying controls.
- D. Accessories Available:
1. Remote “in-room” sensor kit (KRCS01-1).
 - a. Wall mounted, hard wired remote sensor kit for detecting the temperature can be placed away from the indoor unit (branch wiring is included in the kit.).
- E. Wiremold is acceptable to run control cabling provided that it is 18-20 gauge steel with concealed fasteners.
- F. The local Manufacturer’s Representative for the Daikin VRF equipment specified is Briggs Equipment Sales (207) 657-7123.

END OF SECTION 238126

SECTION 238200 – CONVECTION HEATING AND COOLING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Baseboard Radiation.

1.2 RELATED SECTIONS

- A. Division 23 Section “Common Motor Requirements for HVAC Equipment.”
- B. Division 23 Section “Hydronic Piping.”
- C. Division 23 Section “Hydronic Specialties.”
- D. Division 23 Section “Instrumentation and Control for Mechanical Systems.”
- E. Division 26 “Electrical” - Equipment Wiring Systems: Electrical characteristics and wiring connections. Installation of room thermostats. Electrical supply to units.

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

- A. Division 01 Section “Submittal Procedures.”
- B. Product Data: Provide typical catalog of information including arrangements.
- C. Shop Drawings:
 - 1. Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations.
 - 2. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.
 - 3. Indicate mechanical and electrical service locations and requirements.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

- A. Division 01 Section “Closeout Procedures”: Procedures for submittals.
- B. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.
- C. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner’s name and registered with manufacturer.

- D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings. Submit under provisions of Division 01 Section "Operation and Maintenance Data."

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years experience.

1.7 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.8 EXTRA MATERIALS

- A. Division 01 Section "Closeout Procedures": Maintenance Data.
- B. Provide 2 sets of filters.

PART 2 - PRODUCTS

2.1 BASEBOARD RADIATION, SECURITY GRADE

- A. Manufacturers:
 - 1. Sterling Hydronics.
 - 2. Approved equal.
- B. Heating Elements: 3/4 inch ID seamless copper tubing, mechanically expanded into evenly spaced aluminum fins, suitable for soldered fittings. Galvanized steel slide cradles.
- C. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.
- D. Enclosures: Slope-top, equal to Guardian style GSBS 12P with partial perforation, 14-gauge steel, with easily jointed components for wall to wall installation.
- E. Backplate: 14-gauge steel, painted. Full height type, for use with ball-bearing hangers. Support rigidly on wall. Mount at manufacturer's recommended height above floor.
- F. Finish: Factory applied baked enamel of color as selected by the Architect.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

- B. Install equipment exposed to finished areas after walls and ceiling are finished and painted. Avoid damage.
- C. Protection: Provide finished cabinet units with protective covers during balance of construction.
- D. Hydronic Units: Provide with shut-off valve on supply and lockshield balancing valve on return piping. If not easily accessible, extend vent to exterior surface of cabinet for easy servicing.

3.2 CLEANING

- A. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

END OF SECTION 238200

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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. Examine all contract documents for requirements affecting the work.

1.2 SUMMARY

- A. Section Includes:
 - 1. Basic Electrical Requirements specifically applicable to all Division 26 Sections.
 - 2. Intent Is to Provide and Install Complete Electrical Systems, as Required to Accommodate the Existing Building renovations.
 - 3. Electrical equipment coordination and installation.
 - 4. Sleeves for raceways and cables.
 - 5. Grout.
 - 6. Common electrical installation requirements.
 - 7. Access Panels: Where required by NFPA 70 (N.E.C.)

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.
- C. RGS: Rigid Galvanized Steel.
- D. As used in this section, "provide" shall mean, "furnish and install". "Furnish" shall mean "to purchase and deliver to the project site complete with every necessary appurtenance and support", and "Install" shall mean "to unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project".

1.4 OWNER FURNISHED PRODUCTS

- A. Products Furnished to The Site And Paid For By Owner:
 - 1. Tele/data devices and terminations

1.5 REFERENCES

- A. NEMA Standards.
- B. NECA "Standard of Installation."
- C. NFPA 70 (N.E.C.) latest edition.
- D. NFPA 101 Life Safety Code

E. ANSI Standards.

F. ADA requirements

1.6 SUBMITTALS

A. Submit Shop Drawings, Owner's Manuals, and Operating Instructions in accordance with Division 01 Section "Submittal Procedures".

B. Include products specified in Division 26 individual sections.

C. Submit Shop Drawings and product data grouped by individual Sections to include complete submittals of related systems, products, and accessories. Label each with Section number and title. Partial Section submittals will not be reviewed.

D. Include access panels.

E. Include fire-stop seals and fillers.

1.7 RECORD DRAWINGS

A. Keep a marked set of Drawings at the site as a record set indicating all revisions in the work as the work progresses. At the completion of the work, mark the Drawings "As-Built Drawings" with the Contractor's name and date, and deliver to the Architect.

1.8 PERFORMANCE REQUIREMENTS

A. Conform to requirements of the latest edition of ANSI/NFPA 70 National Electrical Code (N.E.C.).

B. Conform to requirements of all local, State and Federal laws and regulations, plus local electric utility company's rules, and the Fire Underwriters' requirements.

C. Furnish products listed and classified by Underwriters' Laboratories, Inc. (U.L.) as suitable for purpose specified and shown.

D. Secure and pay for all permits and certificates as required by local, State and Federal laws.

E. Request inspections from authority having jurisdiction.

F. Run separate circuits for lighting and receptacle outlets as indicated.

1. Circuits shall be balanced and loads and capacities shall be in accordance with requirements of local electric light company and National Board of Fire Underwriters.
2. Do not share neutral on branch circuits.

G. The entire electrical system shall be permanently and effectively grounded in accordance with Code requirements.

H. The Drawings indicate only diagrammatically the extent, layout and the general location and arrangement of equipment, conduit and wiring. Become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment will be properly located and readily accessible.

1. Home runs to panelboards shall not exceed 2-1/2% voltage drop from the furthest device on the circuit.

1.9 ALTERATIONS

- A. Visit the site and become familiar with the existing conditions, and the requirements of the Plans and Specifications. No claim will be recognized for extra compensation due to failure of becoming familiar with the conditions and extent of the proposed work.
- B. Execute all alterations, additions, removals, relocations, or new work, etc., as indicated or required to provide a complete installation in accordance with the intent of the Drawings and Specifications.
- C. Repair or replace to the Owner's satisfaction, all existing work disturbed or damaged by the alterations.
- D. Retain ownership and remove from site all existing materials, equipment, fixtures, wiring and devices disconnected and not reused; Pay all charges for proper disposal of materials.
- E. Do not reuse existing wiring except as specifically indicated. Existing conduit raceways may be reused, provided that the existing wires are removed and new wires are installed.
- F. Provide finished blank plates on all existing ceiling and wall boxes which can not be removed.

1.10 SEQUENCING AND SCHEDULING

- A. Construct Work in sequence under provisions of Division 01 Section "Project Management And Coordination".
- B. Schedule and coordinate all work with Division 01 Section "Temporary Facilities And Controls". Demolition and removal of electrical items are included as part of Division 26. Patching of existing structure left by removals is specified under Division 02 Section "Selective Demolition and Alterations".
- C. Arrange to execute the work at such times and in such locations as may be required to provide uninterrupted services for the building, or any of its sections.
 1. Services Include but Not Limited to: Power, lighting, fire alarm, paging/intercom, nurse call, telephone, computer, and life safety systems as required to maintain occupancy.
 2. If necessary, install temporary work to provide for this condition. Authorization for interrupting services shall be obtained, in writing, from the Owner.
 3. Costs for overtime work and temporary work shall be included in the bid.

1.11 TEMPORARY LIGHT AND POWER

- A. Specified under Division 01 Section "Temporary Facilities And Controls".

1.12 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 with all other trades to ensure proper access and space requirements.
- C. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- D. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.
- E. Coordinate sleeve selection and application with selection and application of firestopping.
- F. Where project conditions occur necessitating departures from the drawings, submit for approval the details of and reasons for departures prior to implementing any change.

1.13 COORDINATION DRAWINGS

- A. As a requirement of this specification, the Contractor shall participate in the development of a set of common coordination drawings for the project.
- B. The mechanical HVAC contractor shall be responsible to manage the coordination drawing effort and submit the drawings as shop drawings for review and comment. The HVAC contractor shall develop the base floor plans and building sections and place his mechanical equipment ductwork and piping on them. He shall then coordinate and manage each Trade's effort while they place their information on the same drawings.
- C. Each trade: Plumbing, fire protection and electrical shall work with the Mechanical HVAC contractor to help produce the coordination drawings. Each trade shall be responsible to coordinate their own equipment, piping, conduit and other associated materials with the other trades and place this information on the drawings.
- D. The coordination drawings may be CAD or hand drafted as selected by the mechanical HVAC contractor. Floor plans shall be prepared at a minimum scale of 1/4" = 1'. Sections through an entire wing shall be prepared at a minimum scale of 1/4" = 1'. Detail sections across corridors or other small areas shall be prepared at a minimum scale of 1" = 1'.
- E. Coordination drawings shall be prepared for all existing areas affected by the work. The drawing detail shall be sufficient to insure coordination between the trades and also with the building structure. As a minimum the following shall be shown in plan and section:
1. Building structure.
 2. All major equipment.
 3. All ceiling-mounted equipment in ceiling grid, i.e: lighting fixtures, HVAC diffusers, sprinklers, etc.
 4. Ceilings in elevation
 5. All duct work
 6. All major duct, pipe, conduit and tray runs
 7. All work in corridors

8. Single pipe and conduits run outside of corridor areas when greater than 1 «" in diameter.
 9. As a minimum, indicate elevation of sprinkler piping in all areas.
- F. Mechanical HVAC, plumbing, fire protection and electrical construction shall not commence until coordination drawings have been reviewed. The Contractor shall bring any coordination issues to the attention of the Architect. Review of the coordination drawings by the Architect does not relieve the Contractor of his/her responsibility to provide a properly coordinated construction project.

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. Sleeves for Rectangular Openings: Galvanized sheet steel.
 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).
- C. Coordinate sleeve selection and application with selection and application of firestopping.

2.2 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.3 ACCESS PANELS

- A. Standard panels: 12" x 16" except as indicated. Doors: flush type 14-gauge steel, hinged to 16-gauge frame. Latch: Flush face screw. All factory primed and painted to match in the field.
 1. Same U.L. fire rating as wall, floor, or ceiling in which they are installed.
 2. Equal To: Inryco/Milcor style "M" and Miami-Carey "HM".

2.4 PAINTING

- A. Refer to Division 09 Section "Painting".

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1, Standard Practices for Good Workmanship in Electrical Contracting.

- B. Execute all work in a neat manner acceptable to the Local and State Electrical Inspector. Follow manufacturer's installation recommendations.
- C. Except as indicated on the Drawings, Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- D. 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.
- E. 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.
- F. Right of Way: Give to piping systems installed at a required slope.
- G. All electrical components and their attachments shall be properly supported and where required shall be designed for seismic forces.
- H. Lighting fixtures shall be supported from structural steel. Provide unistrut channels or equal to span between top cord of joists. See Division 26 Section "Interior Lighting".
- I. Perform all electrical work by licensed electricians well skilled in the trade and supervised by a Master Electrician.
- J. Replace or repair to new condition, defective equipment and equipment damaged during installation or testing.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Furnish and install all sleeves required for the work.
- B. 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.
- C. 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.
- D. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- E. 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.
- F. Cut sleeves to length for mounting flush with both surfaces of walls.
- G. Extend sleeves installed in floors 2 inches (50 mm) <Insert dimension> above finished floor level unless noted otherwise.
- H. Size pipe sleeves to provide 1/4-inch (6.4-mm) <Insert dimension> annular clear space between sleeve and raceway or cable, unless indicated otherwise.

- I. 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.
- J. 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".
- K. 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.
- L. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

3.3 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly.
- B. Manufactured Fire Stopping Sleeves (wiring device).
 - 1. The device shall have an F Rating equal to the rating of the barrier in which the device is installed.
 - 2. The devices shall be provided with steel wall plates allowing for single or multiple devices to be ganged together.
 - 3. Install the devices in strict accordance with the approved shop drawings and the equipment manufacturer's recommendations, including applying the factory supplied gasketing material prior to the installation of the wall plates.
 - 4. Nominal size: Square 3"x3"x10.5" long with capacity equal to a 4" conduit.
 - 5. Devices shall be equal to Specified Technologies Inc.(STI), EZ-PATH Fire Rated Pathways.
 - 6. At each location, provide minimum of two fire rated devices mounted side by side with shared wall flange. Provide additional devices as noted on plans.

3.4 TESTING AND ADJUSTING

- A. The entire installation shall be free from short circuits and improper grounds. Test in the presence of the Architects or their representatives.
- B. Test feeders with the feeders disconnected from the branch circuit panels.
- C. Test each individual branch circuit at the panel. In testing for insulation resistance to ground, the power equipment shall be connected for proper operation. In no case shall the insulation resistance be less than that required by the National Electrical Code and the manufacturer's recommendations. Correct failure in a manner satisfactory to the Architect and Engineers. Completely test and adjust each system specified under Division 26 for proper operation.

END OF SECTION 260500

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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.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control test reports.

1.6 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.

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:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Alcan Products Corporation; Alcan Cable Division.
 - 2. American Insulated Wire Corp.; a Leviton Company.
 - 3. General Cable Corporation.
 - 4. Senator Wire & Cable Company.
 - 5. Southwire Company.
- C. Conductors: Comply with NEMA WC 70.
- D. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.
- E. Multiconductor Cable: Comply with NEMA WC 70 for armored cable, Type AC with insulated ground wire and an HCF (Healthcare Facilities) rating.

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:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of 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.
- C. 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. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Exposed Feeders: Type THHN-THWN, single conductors in metal raceway.

- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in metal raceway.
- C. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in metal raceway.
- D. Branch Circuits Concealed in Ceilings, Walls, and Partitions:
 - 1. Emergency power circuits Type THHN-THWN, single conductors in raceway.
 - 2. Normal power circuits: Armored cable, Type AC, HCF rated.
- E. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- F. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- G. Class 2 Control Circuits: Power-limited cable, concealed in building finishes.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
- F. Identify and color-code conductors and cables according to Division 26 Section "Identification 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. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) 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.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Perform tests and inspections and prepare test reports.
- C. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test feeder conductors for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
 - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
 - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.
- D. 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.
- E. Remove and replace malfunctioning units and retest as specified above.

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

- A. Section Includes: Grounding systems and equipment.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
 - 1. Grounding for sensitive electronic equipment.
- B. Qualification Data: For qualified testing agency and testing agency's field supervisor.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- 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 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 (6 mm) 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 (41 mm) wide and 1/16 inch (1.6 mm) thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.2 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.

- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

- D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

- B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
 - 8. Mammography Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.
- C. 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.

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 bonding so vibration is not transmitted to rigidly mounted equipment.
- C. 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.

3.4 LABELING

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

- C. 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.

- D. 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 a calibrated torque wrench according to manufacturer's written instructions.

- E. Grounding system will be considered defective if it does not pass tests and inspections.

- F. Prepare test and inspection reports.

- G. Report measured ground resistances that exceed the following values:
 - 1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.

- H. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify 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.
- B. Related Sections include the following:
 - 1. Division 26 Section "Vibration and Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.7 QUALITY ASSURANCE

- A. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 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. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 4. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. 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.
- D. 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.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. 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. 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) 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. 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.; 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.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps.

- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT 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 (90 kg).
- 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 (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 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 (0.05 mm).
- B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

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SECTION 260533 - RACEWAYS 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. Section Includes:
 - 1. Metal conduits, tubing, and fittings.
 - 2. Metal wireways and auxiliary gutters.
 - 3. Surface raceways.
 - 4. Boxes, enclosures, and cabinets.

1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.
- C. Samples: For wireways and surface raceways and for each color and texture specified, 12 inches (300 mm) long.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of conduit groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- B. Qualification Data: For professional engineer.
- C. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, 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. AFC Cable Systems, Inc.
 2. Allied Tube & Conduit; a Tyco International Ltd. Co.
 3. Anamet Electrical, Inc.
 4. Electri-Flex Company.
 5. O-Z/Gedney; a brand of EGS Electrical Group.
 6. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
 7. Republic Conduit.
 8. Robroy Industries.
 9. Southwire Company.
 10. Thomas & Betts Corporation.
 11. Western Tube and Conduit Corporation.
 12. Wheatland Tube Company; a division of John Maneely Company.
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. IMC: Comply with ANSI C80.6 and UL 1242.
- E. EMT: Comply with ANSI C80.3 and UL 797.
- F. FMC: Comply with UL 1; zinc-coated steel.
- G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 2. Fittings for EMT:
 - a. Material: Steel or die cast.
 - b. Type: Setscrew or compression.

- I. Joint Compound for IMC, or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

- 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. Cooper B-Line, Inc.
 - 2. Hoffman; a Pentair company.
 - 3. Mono-Systems, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.3 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
 - 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. Mono-Systems, Inc.
 - b. Panduit Corp.
 - c. Wiremold / Legrand.

2.4 BOXES, ENCLOSURES, AND CABINETS

- 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. Adalet.
 - 2. Cooper Technologies Company; Cooper Crouse-Hinds.
 - 3. EGS/Appleton Electric.
 - 4. Erickson Electrical Equipment Company.
 - 5. FSR Inc.
 - 6. Hoffman; a Pentair company.

7. Hubbell Incorporated; Killark Division.
 8. Kraloy.
 9. Milbank Manufacturing Co.
 10. Mono-Systems, Inc.
 11. O-Z/Gedney; a brand of EGS Electrical Group.
 12. RACO; a Hubbell Company.
 13. Robroy Industries.
 14. Spring City Electrical Manufacturing Company.
 15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
 16. Thomas & Betts Corporation.
 17. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Metal Floor Boxes:
1. Material: Cast metal or sheet metal.
 2. Type: Fully adjustable.
 3. Shape: Rectangular.
 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum or galvanized, cast iron with gasketed cover.
- I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- J. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).
- K. Gangable boxes are prohibited.
- L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- M. Cabinets:

1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Indoors: Apply raceway products as specified below unless otherwise indicated:
 1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 3. Exposed and Subject to Severe Physical Damage: GRC.
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 6. Damp or Wet Locations: GRC.
 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in damp or wet locations.
- B. Minimum Raceway Size: 3/4-inch (21-mm) trade size.
- C. 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. Comply with NEMA FB 2.10.
 2. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
 3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- E. Install surface raceways only where indicated on Drawings.
- F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control and tele/data wiring conduits, for which no more than two 90-degree bends are allowed. Support within 12 inches (300 mm) of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. A. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- I. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 1 inch (25 mm) of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
- J. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- N. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

- P. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- Q. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- R. Surface Raceways:
 - 1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
 - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- S. Install raceway sealing fittings at accessible locations according to NFPA 70 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 according to NFPA 70.
- T. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all 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 raceway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- U. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 - 1. Use LFMC in damp or wet locations subject to severe physical damage.
 - 2. Use LFMC in damp or wet locations not subject to severe physical damage.
- V. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- W. 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.
- X. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- Y. Locate boxes so that cover or plate will not span different building finishes.
- Z. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

AA. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

BB. Set metal floor boxes level and flush with finished floor surface.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.4 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260548 - VIBRATION AND SEISMIC CONTROLS 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. Channel support systems.
 - 2. Restraint cables.
 - 3. Hanger rod stiffeners.
 - 4. Anchorage bushings and washers.
- B. Related Sections include the following:
 - 1. Division 26 Section "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 DEFINITIONS

- A. The IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. See structural drawings for seismic information

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 - 2. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

- B. Delegated-Design Submittal: For seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
 - 2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
 - 3. Field-fabricated supports.
 - 4. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
 - c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction], showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
- B. Qualification Data: For testing agency.
- C. Welding certificates.
- D. Field quality-control test reports.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- E. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SEISMIC-RESTRAINT DEVICES

- 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. Amber/Booth Company, Inc.
 - 2. California Dynamics Corporation.
 - 3. Cooper B-Line, Inc.; a division of Cooper Industries.
 - 4. Hilti Inc.
 - 5. Loos & Co.; Seismic Earthquake Division.
 - 6. Mason Industries.
 - 7. TOLCO Incorporated; a brand of NIBCO INC.
 - 8. Unistrut; Tyco International, Ltd.

- B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
 - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

- C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

- D. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.

- F. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.

- G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.

- H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

- I. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

- J. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.2 FACTORY FINISHES

- A. Finish: Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment and Hanger Restraints:
 - 1. Install restrained isolators on electrical equipment.
 - 2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

- B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- D. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, and wireways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 - 5. Test to 90 percent of rated proof load of device.
 - 6. Measure isolator restraint clearance.

7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after isolated equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 260548

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. Section Includes:
 1. Identification for raceways.
 2. Identification of power and control cables.
 3. Identification for conductors.
 4. Equipment identification labels.
 5. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, 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.

PART 2 - PRODUCTS

2.1 POWER RACEWAY 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 size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: 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 for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, 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 for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.
- G. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.2 ARMORED 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. Colors for Raceways Carrying Circuits at 600 V and Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.

- 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. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.3 POWER AND CONTROL 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. 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.
- C. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.
- D. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.
- E. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
- B. 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.
- C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

- E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- F. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.5 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).
- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.
- C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
- D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).
- E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.6 CABLE TIES

- A. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
 - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 - 4. Color: Black.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. 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 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- H. Cable Ties: For attaching tags. UV-stabilized nylon.
- I. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl label. Install labels at 10-foot (3-m) maximum intervals.
- B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. Emergency Power.
 - a. Life Safety
 - b. Critical
 - c. Equipment
 - 2. Normal Power.
- C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in panelboards, switchboards, pull and junction boxes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded 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 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- E. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and future intended use.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal 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 the Operation and Maintenance Manual.
- G. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
- 1. Labeling Instructions:
 - a. Indoor Equipment: Adhesive film label with clear protective overlay. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
 - b. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - c. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 - 2. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.

- d. Emergency system boxes and enclosures.
- e. Enclosed switches.
- f. Enclosed circuit breakers.
- g. Enclosed controllers.
- h. Push-button stations.
- i. Contactors.
- j. Remote-controlled switches, dimmer modules, and control devices.

END OF SECTION 260553

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SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hospital-grade receptacles.
 - 2. Snap switches.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. UTP: Unshielded twisted pair.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.7 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.

1.8 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. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).
 - 4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

- A. Hospital-Grade, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498 Supplement SD.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 8300 (duplex).
 - b. Hubbell; HBL8310 (single), HBL8300H (duplex).
 - c. Leviton; 8310 (single), 8300 (duplex).
 - d. Pass & Seymour; 9301-HG (single), 9300-HG (duplex).
- B. Hospital Grade, Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498 Supplement SD.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; TR8300.
 - b. Hubbell; HBL8300SG.
 - c. Leviton; 8300-SGG.
 - d. Pass & Seymour; 63H.

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. Hospital-Grade, Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with UL 498 Supplement SD.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; HGF20.
 - b. Hubbell; HGF8300.
 - c. Leviton; 6898-HG.
 - d. Pass & Seymour; 2091-SHG.

2.4 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 V, 20 A:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
 - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
 - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
- C. Pilot Light Switches, 20 A:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 2221PL for 120 V and 277 V.
 - b. Hubbell; HPL1221PL for 120 V and 277 V.
 - c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
 - d. Pass & Seymour; PS20AC1-PLR for 120 V.
 - 2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

2.5 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. Illuminated when "OFF."

2.6 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
 2. Material for Finished Spaces: Brushed stainless steel.
 3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.
 4. Material for Damp Locations: Thermoplastic 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.

2.7 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
1. Wiring Devices Connected to Normal Power System: Ivory, unless otherwise indicated or required by NFPA 70 or device listing.
 2. Wiring Devices Connected to Emergency Power System: Red.
 3. Device color shall match its corresponding wall plate color.

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. Pigtail 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 (152 mm) 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 ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

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. Verify that dimmers used for fan speed control are listed for that application.
3. 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: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
2. Test Instruments: Use instruments that comply with UL 1436.
3. 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 of 6 percent or higher 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.
- C. Test straight blade hospital-grade convenience outlets for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz. (115 g).

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 and enclosed switches.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 3. Current-limitation curves for fuses with current-limiting characteristics.
 - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - 5. Coordination charts and tables and related data.
 - 6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT 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.

1.5 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 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.

1.7 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.8 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Cooper Bussmann, Inc.
 2. Edison Fuse, Inc.
 3. Ferraz Shawmut, Inc.
 4. 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 J, time delay.
 - 2. Motor Branch Circuits: Class RK5, time delay.
 - 3. Other Branch Circuits: Class J, 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.
- B. Install plug-fuse adapters in Edison-base fuseholders and sockets. Ensure that adapters are irremovable once installed.

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

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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. Non-fused switches
 3. Molded-case circuit breakers (MCCBs).
 4. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 1. Enclosure types and details for types other than NEMA 250, Type 1.
 2. Current and voltage ratings.
 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 4. Include evidence of NRTL listing for series rating of installed devices.
 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.

- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. 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.
- D. Manufacturer's field service report.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers 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 and circuit breakers.
 - 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.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.9 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

- B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- C. 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.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NFPA 70.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 - 2. Altitude: Not exceeding 6600 feet (2010 m).
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Owner's written permission.
 - 4. Comply with NFPA 70E.

1.11 COORDINATION

- A. 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.

PART 2 - PRODUCTS

2.1 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. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 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. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 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. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 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. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 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. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Square D; a brand of Schneider Electric.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
6. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

2.4 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: 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. Wet or Damp, Indoor Locations: NEMA 250, Type 4.

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.

3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Comply with NECA 1.

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.
 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. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, 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. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. 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

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The image features a solid green background with several white geometric lines. A prominent white line runs diagonally from the top-left corner towards the center. Another white line runs diagonally from the bottom-left corner towards the center, intersecting the first line. A third white line runs horizontally from the left edge towards the right, intersecting the other two lines. In the bottom-left corner, there are several white rectangular shapes of varying sizes and orientations, some overlapping each other, creating a complex geometric pattern.

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